BIENNIAL REPORT OF THE SOUTHEASTERN FOREST EXPERIMENT STATION FOR THE YEARS 1947 AND 1948

PAPER NO. 2

SOUTHEASTERN FOREST EXPERIMENT STATION
ASHEVILLE, NORTH CAROLINA

I.T. HAIG, Director

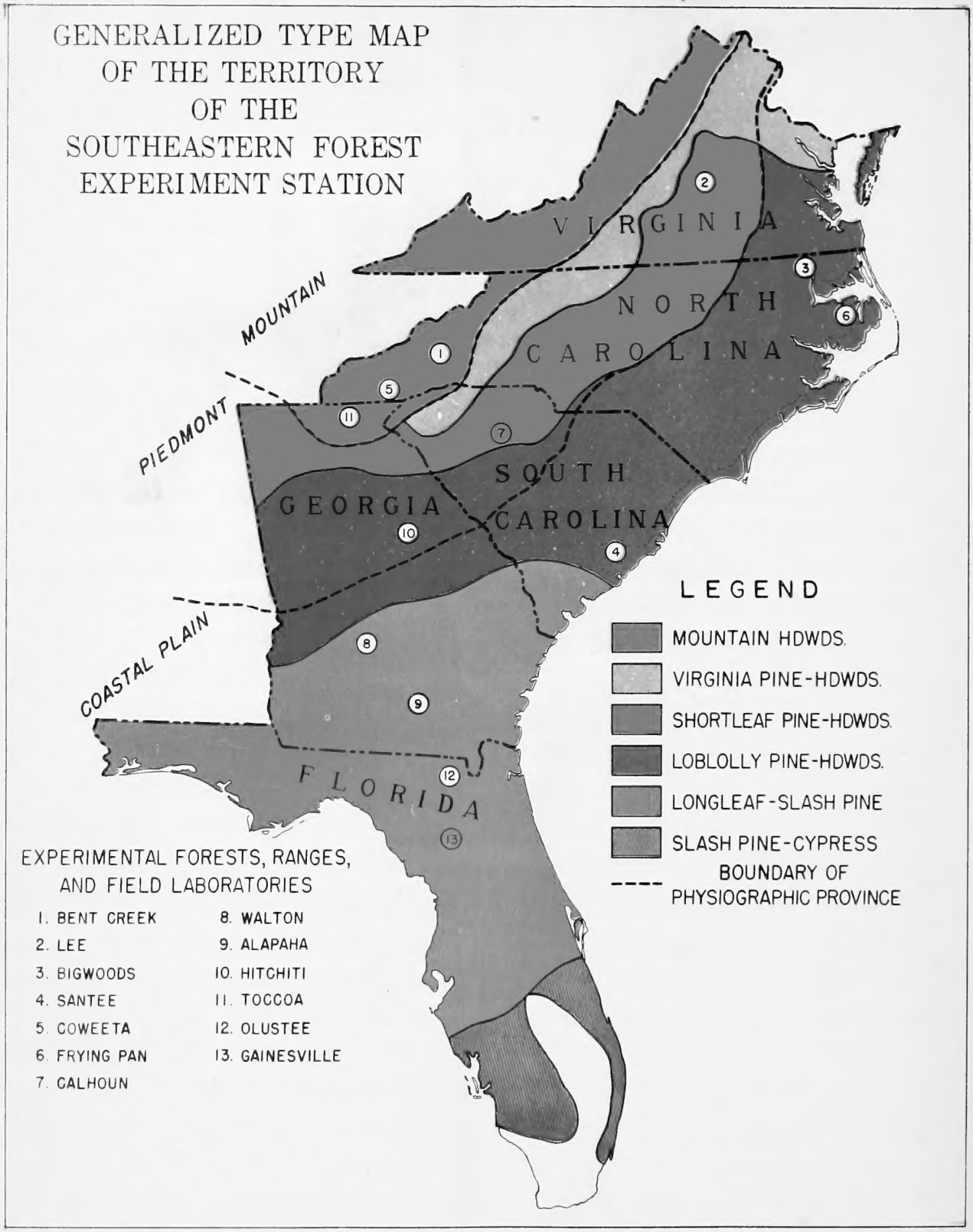
CONTENTS

BIENNIAL REPORT
OF THE
SOUTHEASTERN FOREST EXPERIMENT STATION
FOR THE YEARS 1947 AND 1948

THE REGIONAL SITUATION

In the Southeast (the five coastal states Virginia to Florida, inclusive) as elsewhere, high prices and strong demand continued to characterize the market for forest products of all kinds throughout most of the 1947-1948 period. Pulpwood production in 1947 was 12 percent greater than in 1945, reflecting an increase in capacity at new and existing mills. Lumber production increased over 1945 by about 18 percent. Producing sawmills totalled nearly 13,000, nearly a 60 percent increase over 1942. Forest industry expansion continued, one indication being an increasing demand for resource information as obtained by the Forest Survey. The Station now handles several hundred special requests per year. Though some price adjustment and a more exacting market were clearly indicated at the close of 1948, the probable demand for wood over the next decade or so, both foreign and domestic, promised to remain high.

This encouraging industrial situation was reflected directly in greater interest in forestry possibilities. Large-scale private acquisition continued. By the spring of 1948 the pulp companies alone owned 4 6 million acres in the Southeast, only slightly less than the acreage in National Forests. The number of technical foresters employed in the region increased, though the shortage of technical man power, particularly in specialized fields, remained acute. Educational programs, often industry initiated and sponsored, were pushed vigorously; for example, the "Keep . . . Green" programs organized for better fire protection, and the conservation work of the Southern Pulpwood Conservation and Southern Pine Associations.


GENERALIZED TYPE MAP
OF THE TERRITORY
OF THE
SOUTHEASTERN FOREST
EXPERIMENT STATION
VIRGINIA
NORTH
CAROLINA
SOUTH
CAROLINA
GEORGIA
FLORIDA
MOUNTAIN
PIEDMONT
COASTAL PLAIN
LEGEND
MOUNTAIN HDWDS.
VIRGINIA PINE-HDWDS.
SHORTLEAF PINE-HDWDS.
LOBLOLLY PINE-HDWDS.
LONGLEAF-SLASH PINE
SLASH PINE-CYPRESS
BOUNDARY OF
PHYSIOGRAPHIC PROVINCE
EXPERIMENTAL FORESTS, RANGES,
AND FIELD LABORATORIES
1. BENT CREEK
2. LEE
3. BIGWOODS
4. SANTEE
5. COWEETA
6. FRYING PAN
7. CALHOUN
8. WALTON
9. ALAPAHA
10. HITCHITI
11. TOCCOA
12. OLUSTEE
13. GAINESVILLE

Advice and assistance programs were greatly strengthened. These developments indicate the widespread interest in forestry throughout the South and an encouraging appreciation on the part of landowners and industrialists of the possibilities of growing timber as a business enterprise.

Such interest has already resulted in the South in better fire protection, a greatly expanded forest planting program, better cutting practices (the best in the Nation on both public and private lands), and in an ameliorating situation as shown by the fact that total timber growth in the region now approximates total timber drain (use plus waste).

This is all very encouraging and satisfying. Forestry in the South is an actuality on much land and for many owners, and a rising tide of public interest and better performance is obvious on every hand. Yet, a sensible and balanced appraisal leads inevitably to the conclusion that the total picture is far from satisfactory. The national reappraisal recently completed[1/] reports a situation in which "the Nation's saw-timber supply is declining and, of equal significance, its quality is deteriorating." These generalizations apply to the Southeast. Best estimates show saw timber declining at a rate approximating or exceeding one percent per year. The trees now being cut are inferior in quality and in size, in the Southeast about 20 percent smaller. Less desirable hardwoods occupy many former pine sites. Total growth (cubic feet in trees five inches and up) is in approximate balance with total drain (use plus waste) but at a very low and unsatisfactory level. Indeed, the national reappraisal cites the South as the region with poorest stocking; almost half (46 percent) of its forest lands poorly stocked to denuded. Fire protection also lags; in 1946 over half of southern timberlands received either poor fire protection or none. In the Southeast alone there are some 32 million acres of unprotected timberland.

Forest Survey of South Carolina Confirms National Trends

The reinventory of South Carolina just completed by the Forest Survey

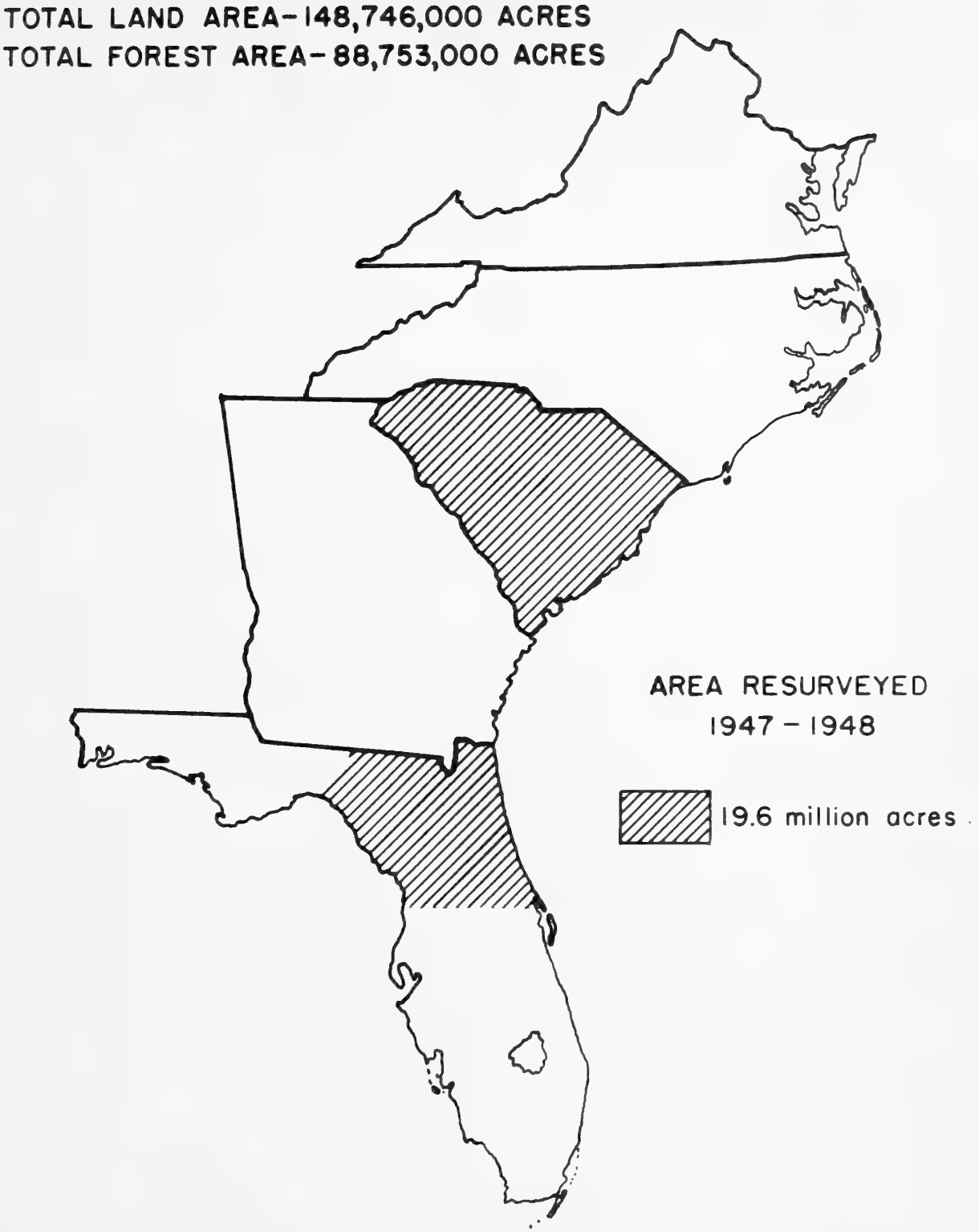
---

1/ Forests and national prosperity. A reappraisal of the forest situation in the United States. Forest Service, USDA Misc. Pub. No. 668. 1948.

unit of the Station confirms a number of these facts. South Carolina statistics, based on detailed field inventories in 1936 and 1947, respectively, show saw-timber stocks going down about one percent per year; total stand decreasing at about half this rate; an increasing area in hardwoods, 40 percent in 1947 as against 27 percent in 1936; while the volume of small, poor quality hardwoods has increased 17 percent as against 11 percent for pine. The growing backlog of volume in pole stands and the improved stocking in seedling and sapling stands resulting from better fire protection and improved cutting practices are encouraging. Yet, growth experts point out that the South now supplies nearly half of all the timber requirements of the Nation from some 28 percent of the Nation's saw timber, and predict that, if 1944 cut and forest practices are continued for 20 years, a decrease of one-third in the present low saw-timber volumes may be expected. It will take a really Herculean effort to reverse current trends. To quote again from the national reappraisal, "Whether we are in for a permanent timber shortage or whether we shall have plenty of timber depends largely on what we do now. We have enough forest land. The challenge is to grow the timber." These words are fully applicable to the Southeast.

Forest Research in General

What does all this mean to a research agency? A rapidly growing and more exacting clientele; increased emphasis on the need for satisfactory knowledge of how to grow timber as a crop, especially on private land for private profit. The reappraisal reports cite four main steps needed to ameliorate the unsatisfactory timber situation: (1) more protection, (2) more planting, (3) less waste, and (4) better forest practices. What has the Southeastern Forest Experiment Station been doing to help attain these objectives? This report is an attempt to present to our "stockholders," the foresters, forest landowners, and forest industrialists of the region, whose taxes support this Federal agency, the progress made in the biennial period 1947-1948. The report deals principally with accomplishments of a practical nature in the field of regional problems. Publication lists in the back of this booklet also cite papers giving details of long-term fundamental research.



Nearly 20 million of the 89 million acres of forest land in the Station territory were resurveyed in 1947-1948.

MORE PROTECTION

More and better protection from fire, insects, and disease is an essential for southern forests. As far as fire protection goes, the emphasis is laid on more protection. The reason for this is that, on the whole, the fire protection record is fairly good where organized fire protection has been available, while southern forests (with notable exceptions, as from the chestnut blight and currently the littleleaf disease) have not suffered from disease or insect damage as some northern or western forests.

Fire damage in the South, 1946-1947
(averages per million acres).

	Number fires	Area burned	Percent burned	Damages
	(Number)	(Acres)	(Percent)	(Dollars)
Protected	404	15,966	1.6	33,321
Unprotected	1,195	217,803	21.8	315,826

Percent of forested area burned, 1946-1947 averages

Region	Protected	Unprotected	Total forest land area
South	1.6	21.8	10.5
North Central	0.3	5.6	1.1
East	0.4	3.5	0.6
Pacific	0.3	-	0.3
Rocky Mountain	0.1	0.4	0.2

This is partial justification for the relatively low priority, except for littleleaf, being given protection problems in the Station's current program. Less than four percent of the Station's budget is being spent on such problems, exclusive of work by the cooperating Division of Forest Pathology. This division's efforts are primarily devoted to study of littleleaf and mimosa wilt. No cooperative research in forest insects

is now under way at the Station except for a few long-time continuing studies requiring little total effort.

Nevertheless, though past research and experience have made a considerable body of knowledge available in the protection field, the situation is not a happy one. There seems little doubt, judging by past experience, that additional research could pay its way many times over, for example, by increasing the efficiency of present fire control procedures. In fire prevention, organized research has scarcely touched such important fields as public psychology and the reasons why 99 percent of fires are still man-caused. Littleleaf continues to cause damage estimated at five million dollars annually and may represent a soils-site problem of even wider scope and importance. The sums being spent for protection in the South, over 10 million dollars in 1949 for fire protection alone, indicate the substantial monetary gains that can be made by even small improvements in knowledge and in the practices and procedures which must be based on knowledge of how fire, insects, and forest diseases behave, and how they can be best controlled.

The following paragraphs give the highlights of research in forest protection fields during 1947-1948:

COMPREHENSIVE FIRE BULLETIN PREPARED

The knowledge gained by 11 years of experience and study on how to measure forest fire danger and apply this knowledge in fire control has now been summed up for practitioners in a comprehensive bulletin. This bulletin will be in print by late 1949 or early 1950.

The first six fire danger stations were established in August 1937 on the Cumberland, Monongahela, George Washington, and Jefferson National Forests. There are now 449 such stations in the East and South, used by states and federal agencies. These stations are an integral part of fire control.

Fire danger records during the Maine forest fires of 1947 indicate how widely fire weather can change and how important it is to know at all times just what these fluctuations really are. September 30 ordinarily

Determining fuel moisture by weighing calibrated wood sticks on a specially constructed scale at a forest fire danger station. Wind velocity is registered by the anemometer as an important fire danger factor.

marks the end of the fire season in southern Maine, and most fire danger stations, used for day-to-day appraisal of burning conditions, were closed at that time. This seemed a sensible course, for Class 2 fire danger prevailed at this time in 1947. The three operating stations, however, showed a gradual build-up from Class 2 to Class 4 by October 14, and after that the danger fluctuated between Class 4 and 5 (the highest class) for nearly three weeks. Whether or not a realization by fire protection forces of the seriousness of burning conditions would have lessened the losses suffered in Maine can never be known. However, it seems clear that the fire danger measurement system in use did furnish the necessary warning. The failure, if any, was in failing to heed this warning rather than in the system of measurement employed.

NEW FIRE DANGER METER WIDELY ADOPTED

A new fire danger meter developed at the Southeastern Station, has been adopted by all of the 193 fire danger stations from Virginia to the north and 25 of those in the Southeast. This meter, based on a 100-point

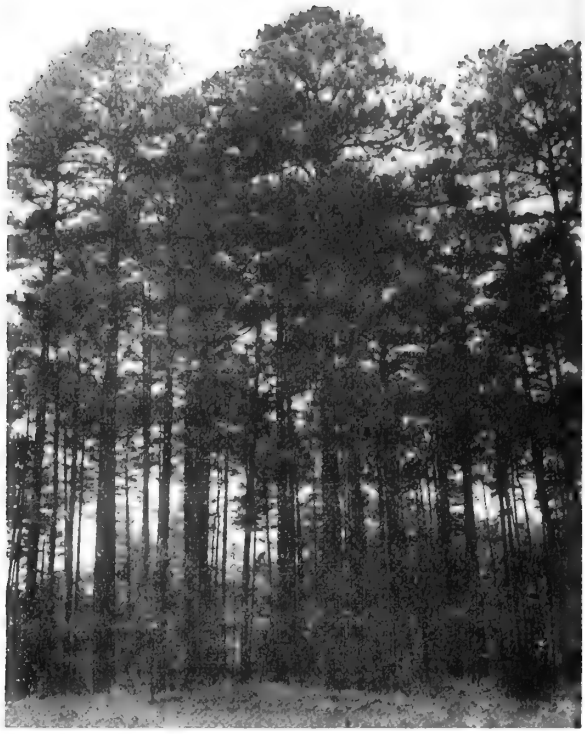
scale instead of five danger classes, permits a more precise and useful evaluation of fire danger. On the new scale the burning index is directly proportional to fire occurrence. The Fire Chief in Rhode Island, for instance, can plan now to handle an average of nine fires in the State when the burning index is 70, and only about four fires when it is 35. Such refinement was not possible heretofore.

NOW POSSIBLE TO MEASURE FIRE DANGER IN THE OPEN

Fire danger can now be measured at convenient open locations if forest conditions are not readily available. To do this, the fuel moisture sticks are shaded with wire screen, and a special meter, Type 5-O, corrects for increased wind velocity, variation in temperature, and other differences.

TOMORROW'S FIRE DANGER CAN NOW BE PREDICTED

The fire danger expected tomorrow can now be calculated in advance from the weather forecast and the danger meter. This represents a major advance in fire danger measurement. Under the system developed, in co-operation between the Station and the U. S. Weather Bureau, Asheville, North Carolina, definite forecasts of fuel moisture and wind velocity are made for the Bureau's Fire Weather District Eight, comprising principally the national and state fire control districts in the Southern Appalachian Region. This replaces a former system wherein broad ranges in humidity and wind velocity were predicted. During the fall fire season in 1948, on the Cumberland National Forests, the Weather Bureau predictions of fuel moisture deviated only an average of 2.7 percent from the actual, a satisfactory performance for the trial run. The dispatchers prefer the new system. Formerly, they had difficulty interpreting the relative-humidity-forecast in terms of fuel moisture. Now they can simply set their fire danger meter to the fuel moisture predicted. Thus they can plan with greater certainty for the organization needed tomorrow.



Healthy trees.

Trees attacked by littleleaf.

POSSIBLE CAUSE OF LITTLELEAF ISOLATED

During the past year the Division of Forest Pathology[2/] compiled definite evidence of a relationship between root mortality and littleleaf, the higher the root mortality the more severe the littleleaf. Shortleaf pines with littleleaf had almost twice as many dead roots as healthy shortleaf of the same age, and healthy older shortleaf had about three times as many dead roots as healthy older loblolly. This indicates that the lower incidence of littleleaf on loblolly is correlated with lower root mortality. The rise in proportion of roots dead in shortleaf, from 3 percent at 15 years to 18 percent at 30 years, explains why we note the onset of littleleaf at or above 20 years.

From the dead roots on littleleaf trees and from the soil about them, Dr. W. A. Campbell, of the Division of Forest Pathology, working in cooperation with the University of Georgia, has consistently isolated a moisture-loving root parasite, Phytopthora cinnamomi. He found it sparingly or not at all in stands of healthy shortleaf. This fungus causes root diseases of chestnut, beech, avocado, and other plants. It is particularly destructive in wet soils, a fact in agreement with the demonstrated high incidence of littleleaf on the more impermeable Piedmont soils.

It is possible, therefore, but not proven, that the direct agent causing littleleaf has now been discovered. The root systems of a large number of trees on different soils have been inoculated with this fungus to see whether littleleaf can be reproduced.

WILT-RESISTANT MIMOSAS DEVELOPED

During 1947-1948 the existence of wilt-resistant strains of mimosa was determined and confirmed. This isolation by selection of disease-immune strains of a tree species has seldom been accomplished in the United States. Selection for disease resistance may be the most effective way of coping with a number of highly communicable tree diseases in the forest, although this

---

2/ Forest pathology studies are under the Division of Forest Pathology, Bureau of Plant Industry, Soils, & Agricultural Engineering, USDA.

requires a planting program.

Resistance tests and satisfactory methods of propagating resistant strains have now reached the point where we are ready to provide wilt-resistant mimosas with fine flower-coloring to the nursery trade.

SAPSTREAK DISEASE OF SUGAR MAPLE FAVORED BY PARTIAL CUTTING

This localized disease has caused heavy mortality of sugar maple on the Pisgah National Forest, particularly among the residual trees left after partial cutting. About 23 percent of such trees, 16 inches d.b.h. and up, have died over the past six years. The only present solution is to cut all merchantable residual sugar maples on cutover areas and all merchantable sugar maples on future logging areas. Sapstreak is not known to occur outside the Pisgah.

NEEDLE FUNGI NOT THE CAUSE OF WHITE PINE NEEDLE BLIGHT

Evidence to date indicates that needle fungi are not the cause of needle blight on white pine. Root aphids are regarded as a possible source of this trouble and are being further investigated.

SUMAC WILT CAUSED BY FUSARIUM

A wilt disease of staghorn sumac (confined to this species) was proved to be caused by a new form of a well known fungus, Fusarium oxysporum forma rhois.

INCREMENT BORINGS CAN CAUSE DEFECT

Increment borings were found to cause heavy staining of the wood for a distance of several feet from the holes in yellow-poplar and the northern hardwoods, sometimes accompanied by decay. All bored sugar maples developed

nectria cankers which resulted in additional defects, and many understory yellow-poplars also became cankered. Pitch soaking occurred in shortleaf pine for about a foot above or below the holes. White and scarlet oak and white pine showed very little defect from increment borings.

MORE PLANTING

Extensive planting is a reality in the South. Yet the reforestation of poorly stocked and denuded lands is a huge job that will take many years. State tree nurseries in the five Southeastern states produced over 50 million seedlings for distribution in 1948. Even so, supplies fell far short of demands. In many states the demands this year are double or treble what they were last year. Production goals for Southeastern state nurseries in 1949 total 98½ million seedlings, and even this will not satisfy requests.

Fortunately, when it comes to setting out these seedlings in southern forests, a solid body of information exists concerning the best species for different sites, methods of planting, chances of survival, costs, and dangers to avoid. This is partially because of excellent past research summed up in Minckler and Chapman's bulletin, "Tree Planting in the Central Piedmont and Southern Appalachian Regions," and Minckler's article, "Old Field Reforestation in the Great Appalachian Valley as Related to Some Ecological Factors," from ECOLOGICAL MONOGRAPHS, April 1946, and in publications by Wakely and others from both the Southern and Southeastern Forest Experiment Stations. As problems of actual planting per se seemed pretty well in hand, this Station has been devoting less than one percent of its work to this field.

But now that seedling production has jumped to such full-scale proportions, it seems logical that research could pay its way improving the techniques and procedures of a broad action program. In their expanded seedling production the nurseries are particularly troubled by diseases which sometimes kill or render unsuitable for planting millions of the seedlings in a few weeks.

Results from Station planting work currently under way include:

HOW TO REPLACE LAUREL SLICKS WITH WHITE PINE

Laurel "slicks," extensive, almost treeless areas in the mountain region where dense laurel and rhododendron brush often occupies productive land and effectively prevents or retards tree regeneration, can be replaced with valuable, fast-growing white pine. Large-scale plantings now confirm earlier studies showing that white pine seedlings, planted in cleared lanes (three-fourths as wide as the laurel is high) will overtop the laurel before the lanes close, and thus reforest the land. Potential returns from the pine should more than pay the cost. This tough problem seems licked as far as technical knowledge is concerned. Fifty thousand white pine seedlings have been planted in laurel thickets of the Pisgah National Forest in the first large-scale application of the method. The lanes are skidroads of a sale area.

METHODS OF PLANTING REDCEDAR TESTED

Redcedar has always been a difficult species to plant on the heavy clay soils of the Piedmont region. However, in some places it grows very well after it becomes established, and produces valuable Christmas trees, posts, poles, and small sawlogs. A recent test of seven different planting methods shows that there was no significant difference in average survival or height growth after four seasons. However, none of the methods resulted in a satisfactorily high rate of survival. The following tabulation summarizes the results of the recent tests.

	Planting method	Average survival (Percent)	Mean height (Feet)
1.	Center hole, 12"-14" scalp	37	1.5
2.	Center hole, 24" scalp	41	1.5
3.	Mattock slit, 12"-14" scalp	25	1.5
4.	Bar slit, no scalp	28	2.1
5.	Bar slit in 4"-deep contour furrows	29	1.7
6.	Same as 5 with limestone added	27	2.0
7.	Center hole, 24" scalp, limestone added	29	1.8

LESS WASTE[3/]

Far too little of the raw materials of our forests appear in the final wood product. Waste in utilizing wood begins in the logging operation and continues at every processing step, including the final sanding of a dining room table. Examples of waste are: cull trees, limbs and other nonmerchantable wood left in the forest; the portion of logs, bolts, lumber, and other raw wood not appearing in the products of manufacture; and losses of wood or degrade caused by mismanufacture or improper processing practices such as miscut lumber and seasoning losses. One of the Station's objectives is to reduce this waste.

AUTOMATIC WOOD-BURNING FURNACE DEVELOPED FOR DRYING TOBACCO

This Station has developed a thermostatically controlled, inexpensive, conveniently operated wood-burning furnace for curing tobacco by working in cooperation with Forest Products Laboratory, the North Carolina Agricultural Experiment Stations, and the Bureau of Plant Industry, Soils, and Agricultural Engineering. Farmers object to staying up all night during the busy tobacco-curing season to stoke old-style wood-burners. For that reason, many tobacco growers are installing coal and oil-burning furnaces. But the use of wood as fuel for tobacco curing is an important outlet for little-used and low-grade hardwood and pine thinnings. The new wood-burning furnace, which holds the required temperature overnight and uses less fuel, should be ready for tobacco farmers by the 1950 curing season. A furnace that burns sawdust has also been tested and found satisfactory.

3/ Most Federal research in waste reduction and similar utilization problems is carried out at the Forest Products Laboratory. The Station's effort is confined to a small Forest Utilization Service, which provides technical liaison between the Laboratory, the Station, the Regions, and wood users and processors.

IMPROVED SEASONING PRACTICES REDUCE WASTE

Because kiln-drying waste at furniture plants amounts to millions of board feet annually, kiln-drying courses were organized in cooperation with Forest Products Laboratory and the Southern Furniture Manufacturers Association to improve seasoning practices. A Wood Seasoning Conference was also arranged. Both were successful, as indicated by the increased interest of manufacturers in reducing seasoning losses and by the numerous requests for the "Proceedings" of the Conference.

EXPANSION OF SMALL RURAL FOREST INDUSTRIES ENCOURAGED

To aid in the better utilization of timber, the Station prepared a bulletin on "Opportunities in Rural Industries - Wood," in cooperation with the North Carolina Department of Conservation and Development, describing the opportunities for small forest industries in North Carolina and giving special consideration to ample permanent timber supplies.

Bundles of fence posts ready to be dipped into a vat of hot creosote at a typical small Georgia plant for preservative treatment.

SURVEY GUIDES INDUSTRIAL NEEDS AND PRACTICES

Surveys, in cooperation with Forest Products Laboratory, were completed of the needs and practices in the Southeast of the softwood distillation, veneer and plywood, pulp and paper, fruit and vegetable-container, and dimension stock industries, as well as finishing practices at furniture plants. These serve not only to furnish on-the-spot advice and guidance for some plants, but, more important, to give the Laboratory a better view of Southeastern industrial wood utilization and processing problems as a guide to proper orientation of the Laboratory's program.

BETTER FOREST PRACTICES

About four-fifths of the Station's current effort is directed toward the development of better forest practices, particularly better cutting practices, rated the most important step needed to reverse the downward trend of forest growing stock. This is especially important on lands in farm or other small private ownership. Results from 1947-1948 activities include:

GOOD FARM WOODLAND MANAGEMENT PAYS

Experimental cuttings on farm woodlands are showing how well-integrated forest management can be practiced on small holdings at a profit. Off-season work by farmers with normal farm equipment netted about $1.00 per hour in wages in two studies over a four- to five-year period. This was labor profit only. At Bent Creek the gross return per hour varied from $0.81 for fuel wood to $2.50 for black locust posts. This illustrates the possibility of higher returns from good selective management.

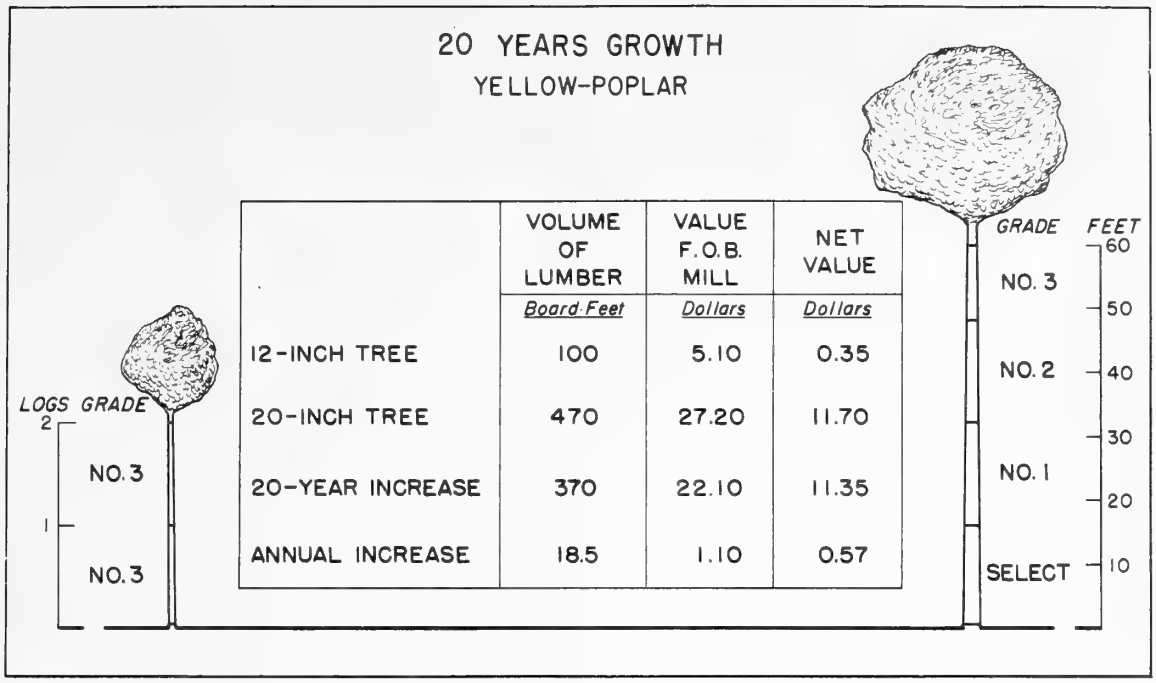
Product	Gross return per hour
Saw timber	$1.95
Pine pulpwood	.90
Fuel wood	.81
Black locust posts	2.50
Dogwood bolts	1.52
Tanbark	.97
Acidwood	.96

All profits were from improvement cuttings in understocked rundown woodland areas. All operations left the woodland in more productive condition.

WHAT TREES SHOULD I CUT?

Commercial size (pilot-plant) cuttings on experimental forests are now beginning to yield information on this key question, not only on silvicultural aspects, about which considerable is already known, but also on financial aspects, about which very little is known. Which trees, by species and size, will yield the highest return? Will it pay to hold trees longer for quality and value increment? What does it cost to harvest and manufacture lumber and other forest products from trees of various species and size?

The answers to such questions, as they relate to lumber, are becoming available from over 1,000 acres of commercial-sized experimental cuttings. We already know how to rank common hardwood species according to their lumber production value. For example, good trees 18 inches in diameter rank in decreasing value by species as follows: sweet birch, sugar maple, white ash, basswood, yellow-poplar, white oak, chestnut oak, red maple, northern red oak, and black and scarlet oak. As to marketing size, we know that only northern red oak and yellow-poplar can be expected to return three percent or more of compound interest if held until 24 inches d.b.h. Sweet birch and sugar maple will not justify holding beyond 20 inches d.b.h. The other hardwoods studied reach economic maturity at 22 inches d.b.h. Tables are available that show the lumber grade recovery by tree quality classes for important hardwoods and pine. For example, at the Bent Creek Experimental



	VOLUME OF LUMBER	VALUE F.O.B. MILL	NET VALUE
	Board Feet	*Dollars*	*Dollars*
12-INCH TREE	100	5.10	0.35
20-INCH TREE	470	27.20	11.70
20-YEAR INCREASE	370	22.10	11.35
ANNUAL INCREASE	18.5	1.10	0.57

The above tree increased in volume nearly 5 times during 20 years' growth. During the same period it increased more than 28 times in net value. Both tree values are based on 1948 prices.

Forest, studies show that the yields for a two-log, 30-inch northern red oak are:

Lumber grade	Tree grade A (%)	B (%)	C (%)
FAS	29	17	4
Sap & select	11	8	3
1 Com.	30	32	34
2 Com.	17	25	37
3 A	8	11	16
3 B	5	7	6

On the Santee Experimental Forest four tree grades have been devised that show substantial differences in average value of various kinds of standing trees. For example, the cash value of one thousand board feet of lumber cut from 20-inch, 3-log loblolly pines is:

Lumber grade	Tree grade			
	A	B	C	D
B & Better at $170 per M	$14.08	$ 9.86	$ 4.90	$ 2.45
C at $160 per M	8.64	8.64	5.18	1.73
No. 1 Com. at $85 per M	7.34	6.72	5.81	3.98
No. 2 Com. at $80 per M	9.79	12.64	17.86	22.18
No. 3 Com. at $50 per M	.72	.55	.36	.54
Total	$40.57	$38.41	$34.11	$30.88

Obviously, such figures when supplemented by those for other products will be very useful to the forest manager in reaching decisions as to when to cut and what to cut under selection or other stand improvement or partial cutting operations.

POOR MARKETING PROCEDURES ARE A BAR TO BETTER FOREST PRACTICE

A case study of farm timber marketing procedures made during 1948 for Monroe County, Georgia, shows that nearly two-thirds of the farmers selling saw timber in this typical forested county were unable to evaluate their timber properly for immediate sale. These men received an average of $8.25 per thousand, while those who had accurately appraised their timber averaged $11.90. Many farmers were unaware of the annual growth and income their stands could produce if placed under adequate management. For example, of 79 sellers of farm stumpage only 46 percent intended to operate their stands on a permanent basis and had established regular cutting cycles. The remainder either had no plans at all or had put no plan into operation. This is a clear-cut indication of the need for a greatly expanded educational and assistance program, long recognized in forestry circles.

STAND IMPROVEMENT

Another substantial research contribution during the 1947-1948 period was the preparation of a handbook outlining timber stand improvement methods for the Appalachian and surrounding Piedmont regions. This was a joint contribution from the Station (Forest Management) and from

the Division of Forest Pathology (BPISAE). The bulletin will outline the best methods for improving hardwood, pine hardwood, pine, and spruce fir forests. Recommended treatments for young, intermediate, and old-growth stands are described for each major type. The understocked and run-down condition of mountain and Piedmont forests has already been mentioned, and this bulletin (which will be printed in 1949) should be of real help in furnishing foresters and operators with sound technical knowledge on which to base such operations.

HOW TO CONTROL UNDESIRABLE HARDWOODS

Studies at the Santee and Bigwoods Experimental Forests and elsewhere show that undesirable low-value hardwoods encroaching on loblolly pine sites can be controlled by a variety of methods varying widely in effectiveness and cost. The importance of this work is indicated by the fact that the ten million acres of loblolly pine in the Carolina and Virginia Coastal Plain is one of the most productive forest types. Hardwoods--in many cases of less desirable and slower growing species--are encroaching

Outside and inside of slabs showing principal types of knot indicators recognized in the Santee Tree Grading System: (1) branch, (2) open knot, (3) overgrown knot. All are in the two- to four-inch size class.

on about half of this area. Possible methods of control include prescribed burning, chemical control, and mechanical control (disking and bulldozing), as well as the time-honored methods of cutting and girdling.

An urgent forest management problem is to find efficient methods of regenerating pine in dense understory hardwoods such as this.

Prescribed Burning

If the hardwoods are small, prescribed burning looks like a cheap, effective tool. Fire can be used safely by skilled men to kill hardwoods up to 1.5 inches d.b.h. It will serve to keep hardwoods small and within controllable size if used occasionally during the life of the stand and at the time of harvest cut.

Chemicals

The new silvicides, such as 2,4-D and 2,4,5-T, used as foliar sprays are very effective with many species. They have the advantage of

killing many hardwood root stocks, thus permanently reducing the number of competing hardwood stems. Used in conjunction with fire (to knock hardwoods back to small size, for it is not practical to spray vegetation that is more than four to five feet tall), they offer great promise. However, they are expensive; at present, costs are about two to three dollars per acre for chemicals alone. Several facts stand out regarding the use of the salts of 2,4-D:

1. Complete foliar sprays, used with a wetting agent, will kill most woody shrubs and trees and their root systems.

2. Some species, such as myrtle, are highly resistant to 2,4-D.

3. Better results with sprays are obtained in August as compared to June or October.

4. It is not practical to spray vegetation taller than four or five feet, i.e., hardwood sprouts over one to two years of age.

Larger hardwoods (three inches in diameter and up) can be successfully controlled with Ammate (ammonium sulfamate) when the dry chemical is placed in hacks or cups at the base of the trees. A recent test at the Bigwoods Experimental Forest near Franklin, Virginia, shows the following production per man hour in poisoning with Ammate:

Crew organization	Cups chopped (Number)	Total trees (Number)	Average d.b.h. (Inches)
1 man chopping and poisoning	102	35	7.6
1 man chopping, 1 poisoning	84	31	7.3
2 men chopping, 1 poisoning	108	36	8.0
3 men chopping, 1 poisoning	92	35	7.3

This is cheaper than girdling or felling.

Mechanical Control

Breaking up and uprooting hardwood brush by bulldozing or disking is another possibility. A satisfactory job of disking was done recently on the Bigwoods Experimental Forest for about $4.85 per acre, using an Athens 6-disk, heavy duty, fire maintenance plow. Bulldozing has been extensively tried in Virginia on lands of the Chesapeake Corporation.

It is particularly effective where larger hardwoods have captured a pine site. Like fire and chemical sprays, the mechanical methods do not spare desirable pine regeneration; they merely prepare for pine regeneration, giving it an equal start with hardwood sprouts.

Girdling or Felling

The release of young pines by cutting or girdling overtopping or competing hardwoods is, of course, an additional possibility. The effectiveness of several types of release cutting is being studied. One possible serious effect of release was the sharp increase in tip moth damage. Forty-five percent of all study trees were attacked the first year of the study. The trees that had been completely overtopped were hit especially hard. The percentage of loblolly pines damaged by tip moth is as follows:

Class of trees at beginning of study	Unreleased trees (Percent)	Released trees (Percent)
More than 1/3 of crown free	25	30
Leader only in clear	36	48
Completely overtopped	45	60

Work Needed

It is evident that further study of hardwood control is needed before a completely sound program can be recommended for the many types of hardwood control problems that exist. Some of the aspects needing further study are: What response do understory hardwoods show when pine stands are thinned? What are the sprouting characteristics of different species? How effective are esters of 2,4-D and newer chemicals such as 2,4,5-T? How fast do hardwoods resprout after mechanical control? Then there is the all-important problem of soil-site classification; we must be able to judge the relative value of sites for pine versus hardwoods before a sound program of hardwood control can be designed. We need to know whether repeated fires damage loblolly pine sites.

Fire Behavior Studied

Another important aspect of hardwood control is being attacked through studies of fire behavior, with special attention to fire intensity. Such information is of particular importance in the South and Southeast, where the increasing use of prescribed fire for hazard reduction and hardwood control makes it essential to know just how a fire will burn under various conditions, and particularly how hot it will burn, and what damage it may do. Preliminary studies, for example, indicate that the scorch line in the live crowns of pine trees may be ten times as high on a bright, sunny day as on a bleak, cloudy day, other factors being equal. These variations can obviously be of extreme importance. We know, for example, that some two-thirds of slash pine saplings up to two inches d.b.h. will die if the whole crown is scorched and 40 percent of the needles burned off, but that very few of the trees will die if none of the foliage is consumed and the crowns scorched less than 70 percent. The problem is extremely complicated by character and condition of vegetation, weather, fuels, and so on. Results are sometimes unpredictable on the basis of present knowledge--as is shown by test fires on the Francis Marion National Forest, where, in the important zone close to the ground, backfires were some 25 percent hotter than headfires. In prescribed burning where it is desired to minimize damage to reproduction under 18 inches in height, headfires may sometimes prove more economical and effective than the backfires now so commonly used. If forest managers are to use fire and control it properly, we must know more about its behavior under controllable conditions. Experimental work now under way at the Southeastern Station is aimed at getting the facts and principles underlying fire behavior as an aid to improved forest practice.

CAN PINE BE MANAGED FOR PULPWOOD?

"How can I manage my loblolly pine forest to produce the greatest volume of pulpwood?" This is a question frequently asked by landowners in the Coastal Plain who are interested in short rotations and early returns on their growing stock capital. We know from past work that the average

annual growth of loblolly pine on fair sites maximizes at about 30 to 35 years of age. Short rotations are indicated when the intent of management is to produce high volume rather than quality timber. Unfortunately, loblolly pine seed trees of this age, grown in fully stocked stands, will not, after the rest of the stand is cut, produce enough seed to seed in the area quickly to a second crop. The years of delay required for these young trees to attain seed production permit the establishment of competing hardwoods that smother out the more desirable pine reproduction. The Station is now testing three things that can possibly make management for pulpwood production feasible: First, methods of planting or direct seeding clear-cut areas. Second, treatment of potential seed trees before the final harvest cut, so that they will be in full seed production when the seed is needed. Third, studies of seedbed conditions so that satisfactory restocking can be obtained with minimum amounts of seed from young trees.

A seed-tree strip-cutting on a commercial-sized compartment in a loblolly pine forest of coastal Virginia.

Seed Production

Preharvest release, fertilization, and mechanical wounding are all being tested as seed production aids. Early results indicate the favorable effect of isolation on the seed production of mature trees. The seed strips on two compartments cut early in 1946 had one year to react to the more open environment before the cones formed which produced 1948 seed. The comparison with uncut compartments is revealing.

Sound seed production per acre as of December 1947 and December 1948

Compartment	Sound seed		1948 as percent of 1947
	1947	1948	
	(Thousands)	(Thousands)	(Percent)
Strip cut	59	48	81
Strip cut	57	52	91
Uncut	344	15	4
Uncut	230	10	4
Uncut	139	2	1

Although 1948 was a poor seed year in general on uncut compartments (an average of 3 percent of 1947), the strips on the cutover areas had nearly as good a year in 1948 (an average of 86 percent of 1947). Part of this good record in 1948 is due to the higher percentage of sound seed from the strips. Viability averaged 60 percent compared with 31 percent for seed from the uncut areas.

We are now working on methods of predicting seed crops. If reliable estimates can be made one year in advance of seed fall, particularly for cutover areas, landowners may be saved thousands of dollars by knowing how to time site-preparation measures and other treatments. The system will work like this: By sampling, the forester will determine the average number of green cones per tree. The number of sound seeds per cone produced when the cones ripen the following year will be equal to 37.21 plus 0.37 times the estimated number of cones on the tree.

Seedbed Preparation

It is well known that pine seeds germinate better on mineral soil than on leaf litter or pine straw. Recent pilot-plant treatments to remove or disturb litter by burning or scarification have yielded some useful information. At the Bent Creek Experimental Forest, the openings in a shortleaf pine-hardwood stand were scarified after logging by dragging a stump behind a small tractor. Total costs for machine, driver, and scout were $1.25 per acre. In midsummer following the treatment, there were 28,000 pine seedlings per acre on the scarified spots but only 6,000 on the untreated area. Subsequent mortality will eliminate many of both classes.

In the Coastal Plain loblolly pine type it was found that better seedling establishment and growth resulted on areas disturbed by tractor logging and prescribed burning than on areas where there was no disturbance. After a bumper seed year, seedling survival was as follows:

Surface condition	Seedling distribution	
	Per acre (Number)	Stocking 1/ (Percent)
Undisturbed	2,600	80
Some disturbance	8,796	100
Bare soil	12,107	100
Slash	1,062	56
Lightly burned	7,077	100
Moderately burned	5,882	94
Severely burned	8,364	100
Burned (wt. ave.)	6,927	98
Unburned (wt. ave.)	6,375	87

1/ If each milacre contains one or more seedlings, the tract is classed as fully stocked.

Stocking was poor in slash areas, better on undisturbed litter, but best on disturbed and burned surfaces.

In a greenhouse study it was also found that bare soil gives seed a better chance to absorb the moisture necessary for germination. The germination percents became progressively poorer from well-burned to

undisturbed litter surfaces for both pine and hardwood litter types. Blocks of soil moved intact into the greenhouse were used in the study.

Litter type	Surface condition		
	Undisturbed (Percent)	Burned (Percent)	Logged (Percent)
Pine	68	88	94
Hardwood	65	68	88

Forty-five percent of the seedlings died during the study, and of these 83 percent died because the roots failed to penetrate the soil. Establishment on exposed, heavy soil was poorer than on light, sandy soil. On one soil sample taken from a jammer set where logging machinery had compacted the soil, 100 percent of the seeds germinated, but 84 percent of the seedlings died because their roots could not penetrate the soil. Root growth was slower, too, on heavy soils as shown below:

Soil textural class	Depth of root penetration (millimeters)
Light sand	35
Medium loam	32
Heavy clay loam	22

Seedling height growth is superior on burned and disturbed surfaces for at least two years as shown by recent averages for loblolly pine.

Percent of two-year-old loblolly pine seedlings that exceed indicated heights

Surface soil condition	Best 20 percent (Inches)	Best 40 percent (Inches)	Best 60 percent (Inches)
Burned	28	19	14
Disturbed	16	11	9
Undisturbed	14	10	8
Slash piles	10	9	-

WATER QUALITY IMPAIRED BY LOGGING

Better cutting practices on industrial and municipal watersheds in the Southeast are essential if these areas are to continue to supply usable water at reasonable cost. Recent studies at the Coweeta Experimental Forest show that uncontrolled logging, following common logging practices in the Southern Appalachians, can seriously impair water quality by increasing stream turbidity. Turbidities as high as 3,500 parts per million (p.p.m.) were recorded from the logged area during storm periods. As the allowable turbidity from drinking water is 10 p.p.m. (otherwise an expensive filtration plant is required), the damage done by uncontrolled logging is obvious. Records from a logged area show average turbidities of 93.7 p.p.m. as against 4.3 p.p.m. from a comparable unlogged area.

It is believed, however, that stream sedimentation caused by logging can be reduced to an almost negligible amount by more efficient assess-road location and maintenance, together with improved skidding techniques. Investigations along this line have been started.

LOGGING EFFECTS NOT SERIOUS ON BACTERIAL CONCENTRATIONS

On the other hand, logging operations have not been found to increase bacterial concentrations seriously. Comparisons of stream water from several experimental watersheds at Coweeta are tabulated below:

Source of water	Total bacteria count per milliliter (standard agar test)
Undisturbed forest, Watershed No. 34	15
Undisturbed forest, Watershed No. 16	19
Logged area, Watershed No. 10	110
Cultivated area, Watershed No. 3	348

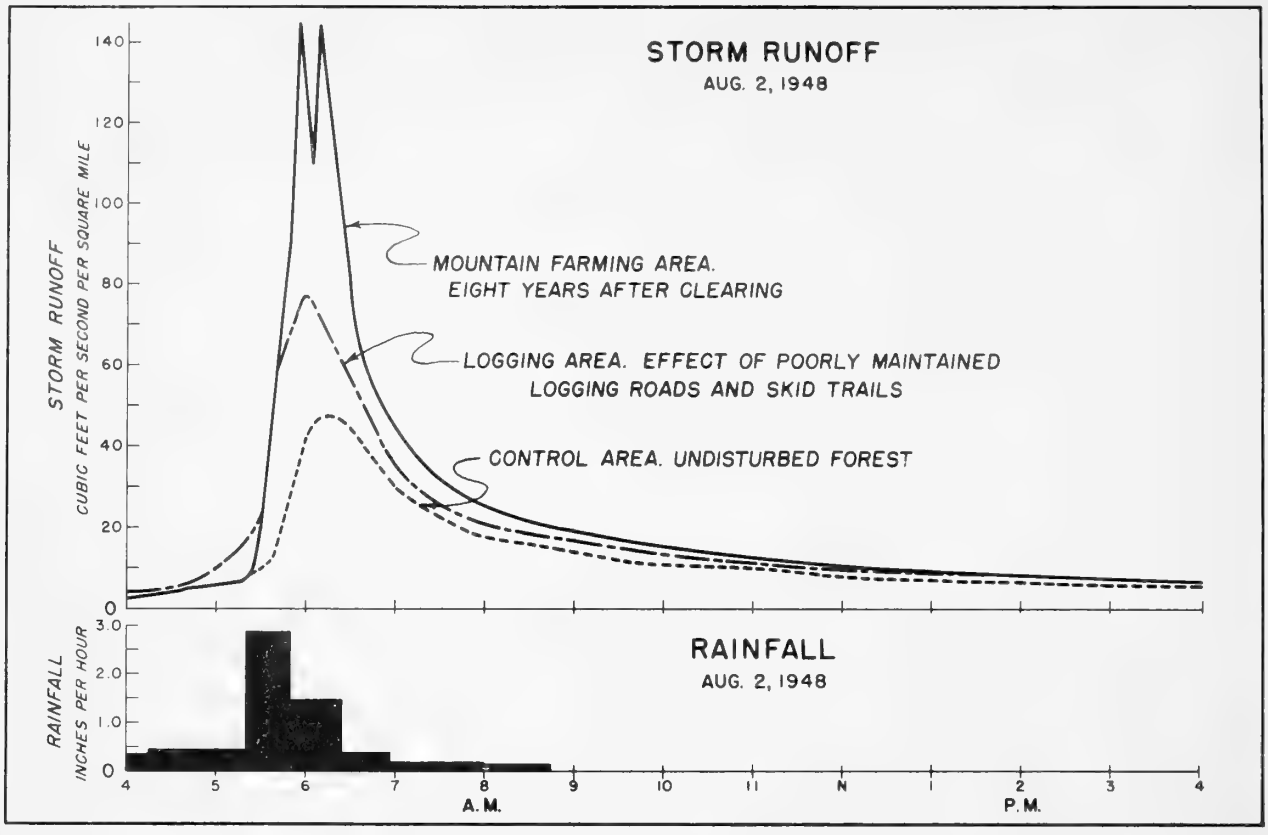
It will be seen that there has been an increase in the number of bacteria from both the logged area and from the cultivated watershed. As

the total bacteria count increases, the number of pathogenic bacteria increases also. Nevertheless, the actual bacteria counts shown above are still low enough to be taken care of by routine disinfection treatments. In fact, with present-day improvements in disinfection treatment, including breakpoint chlorination and the use of chlorine compounds such as chloramines, chlorine dioxide, etc., it is probable that increases in the bacterial concentration brought about by limited land-use practices, such as taking out wood products, are not likely to change the bacterial concentration of the stream beyond a point easily controlled by disinfection. As disinfection is a legal requirement on watersheds supplying public needs even if such watersheds are closed to all use, no additional expense will be required. This clarifies a controversial point that has restricted multiple use on important watersheds.

IMPROVED TECHNIQUES AID WATERSHED RESEARCH

The bulk of work in forest influence (watershed) studies continues to go into fundamental hydrologic research in forest-streamflow relations. The practical value of this work is best demonstrated by the increasing number of visitors, 419 in 1948 alone, chiefly forest technicians, who have visited the Coweeta area to learn first hand of recent advances in our knowledge of forest hydrology and the effects of various types of land use on mountain stream flow.

Much of this is poineer work and frequently even methods of measurement and comparison must be originated. During 1947-1948 several important advances were made in techniques. One was the development of an improved method for expressing water balance which permitted the elimination of the soil moisture variable. Another was the adoption of flow frequency discharge curves as a useful tool in comparing sets of stream-flow data. This method is particularly useful in comparing areas where there has been a change in the base yield of a stream as, for example, where a change in water yield has been brought about by the removal of vegetation. Such tools are obviously useful in a field where attention must be given to such problems as seasonal water storage and the response of streams to vegetative changes.



These streamflow records of August 2, 1948, show the differences in the storm runoff patterns from three experimental watersheds at the Coweeta Hydrologic Laboratory. All three watersheds were first studied together while still under natural undisturbed forest cover and during this period their stormflow records were almost identical. Consequently, the hydrograph for the forested watershed shown above represents the storm runoff that would have occurred from all three watersheds had not experimental treatments been put into effect.

In 1940, one of the watersheds was cleared and subsequently operated as a small mountain farm. Since then about one-third has been cultivated in corn, one-third used as pasture, and the remainder has grown up in sprouts and brush. The peak discharge for the storm shown above was at a rate of 141 c.s.m. (cubic feet per second per square mile). The maximum peak ever recorded for this watershed since cultivation has been 400 c.f.s. A bridge opening would have to be about 20 feet wide and 10 feet high to carry this amount of water for one square mile of watershed.

On the second watershed, logging was carried out at intervals from 1942 to 1948. During this time a logging road system of 2.3 miles was built into the watershed and numerous skid trails were developed. Local unsupervised logging practices were permitted and no efforts were made to control erosion and prevent concentration of water in the ruts. These haul roads and skid trails are directly responsible for the increased storm runoff. The storm record shows a peak discharge from the logged-over watershed of 77 c.s.m., as compared with 34 c.s.m. for the undisturbed, forested control watershed.

FORESTS AFFECT LOCAL CLIMATE

During 1948 the Station's findings on the effect of forest removal on local climate were published as Department of Agriculture Circular No. 774. This report covered four years of records taken in the Copper Basin of Tennessee, where smelter fume damage has produced a land area near Ducktown of about 11 square miles of denuded land completely bare of vegetation. Records were taken within this bare area, in the encircling belt of grassland, and in the adjacent forests. It was found that all of the

Eleven square miles of former hardwood forest denuded of vegetation by smelter fumes in the Copper Basin of Tennessee. Even moderate rains now produce flood conditions. Storm runoff has scoured many slopes to bare rock. Measurable climatic changes in this man-made desert have produced conditions less favorable than formerly to vegetation establishment and growth.

important elements of the local climate have been modified in some degree by forest removal. For example, mean summer maximum air temperatures were 2.1° - 3.5° F. higher in the bare zone than in the forest. Wind velocities were increased from 5 to 15 times. Consistent minor differences were found in the amount of rainfall that is now occurring in the completely denuded central portion of the Copper Basin, as compared with the grassland and forest immediately adjacent. For any six-month period throughout the entire four years of records there was less rainfall in the barren and eroding central portion of the Basin than in the surrounding vegetated areas. Results of the study explain the critical climatic difficulties associated with planting bare and eroding soil. The changes that have taken place are unfavorable in terms of plant-growth-site potentialities. They also emphasize the need for windbreaks and shade tree plantings to improve dwelling sites and habitations in the Southeastern states.

UNNATURAL WATERLOGGING RESULT OF SOIL ABUSE

Observations at the Calhoun Experimental Forest show an unnatural condition of waterlogging of depleted upland Piedmont soils throughout the winter months, believed due to improper land usage in the past. This results in disturbance of both normal porosity and the natural drainage system. On this 12,000-acre tract, more than three-fourths of the original topsoil has been removed on 72 percent of the area. During the winter, there is standing water close to the surface on many areas. In the summer we know these same soils are extremely hard and compact and subject to severe drought conditions between rainstorms.

The effect of the altered hydrologic processes is expressed in poor plant growth, severe soil erosion, stream flooding, and decreased ground water for pumping. The effect on tree growth is illustrated in the following table, taken from a recent cooperative study with the Soil Conservation Service:

Tree growth by land class

	Land class[1/] (Helena-Vance soil)				Land class[2/] (Cecil soil)	
	II	III	IV	VII	II	VII
Survival percent	77	61	67	40	65	34
Present trees per acre	700	550	610	360	590	310
Average diameter, in.	5.97	6.62	4.94	4.33	6.54	4.54
Total diameter per acre, in.	4,177	3,643	3,012	1,559	3,859	1,408
Basal area per acre, sq. ft.	142.4	136.5	90.1	49.9	142.1	42.0
Average height, feet	45	42	34	28	46	25
Volume, cu. ft. per acre	2,143	1,899	1,039	494	2,153	364
Volume, cords per acre	26.8	23.7	13.0	6.2	26.9	4.6
Growth rate, cds./ac./yr.	1.7	1.5	0.8	0.4	1.7	0.3
Present value at $2.00/cd.	53.60	47.40	26.00	12.20	53.80	9.20
Date diameter growth slowed	1940	1941	1941	1943	1941	1943

1/ The Class II land had 3 percent slope and only slight erosion; the Class III, 6 percent slope and moderate erosion; the Class IV, 12 percent slope and very severe erosion; and the Class VII, 17 percent slope and very severe erosion.

2/ The Class II land had a 2 percent slope and only slight erosion, and the Class VII, 12 percent slope and very severe erosion.

It was found that tree growth corresponds to the eight land capability classes developed by the Soil Conservation Service, in much the same manner as do cultivated crops and pastures. The major factors which distinguish one land class from another are kind of soil, steepness of slope, and degree of erosion damage. For example, the Cecil series of soils are recognized as a uniformly productive major soil series of the Piedmont. Nevertheless, it was found that the average growth of the pine stands varied from 0.26 cords per acre per year for a Cecil soil in need of extensive erosion control measures (capability class VII), up to 1.59 cords per acre per year for a Cecil soil where only minor erosion control measures are required (capability class II). For Vance and Helena soils the average growth in cords per acre per year ranged from 0.36 to 1.58 cords per acre per year, depending upon their capability classification.

These findings have a particularly important application at the present time in giving us an idea of the wide range of differences in quality and growth from existing old-field stands that have become established through

natural regeneration. These studies demonstrate the poor site quality inherent in severely eroded and exhausted soils. Since most of the old-field land becoming available for plantations in the Piedmont and southern mountains is in the low capability classes, further intensive research is required for finding out ways of establishing suitable vegetation for soil rehabilitation and water control.

MOUNTAIN GRAZING UNDESIRABLE

The often expressed belief that woodland grazing is undesirable, both from the standpoint of forest production and water yields, is given additional support by data recently compiled from Coweeta studies.[4/] Although the cattle stocking was light, an average of 500 animal days each year for 9 years during May through August on a 145-acre tract, conspicious changes have taken place in the vegetation cover. Based on preliminary counts of plants between the height of 3.5 inches and 15 feet (a range that includes most of the plants that are eaten and browsed by cattle) the following table shows what has taken place in the more heavily grazed portions of the watershed. Data are given showing the change in the number of plant species and number of plants, expressed as a percent of the original number present before grazing.

Effect of grazing hardwood forest

	Number of species	Number of plants
	(Percent change from the original number present)	
Trees	-71	-61
Shrubs	-67	+220
Legumes	-100	-100
Grass	-67	-27
Other herbs	-86	-68
All vegetation	-78	-43

4/ Field examinations of vegetation in 1947 by Dr. Budd E. Smith, Professor of Botany, Wake Forest University; in 1940 by Dr. A. E. Radford, Curator of Herbarium, Department of Botany, University of North Carolina.

It is obvious from the above table that persistent and continuous grazing of mountain hardwoods will result in a progressive decrease in the amount of tree reproduction and in the amount of legumes, grasses and other herbaceous plants suitable for browse. This is accomplished by an increase in the number of persistent shrubs. The first tree species to disappear were yellow-poplar, black locust, and white oak. On the other hand, red maple--a less desirable timber species--is eaten very little by cattle. Over a period of decades this will be expected to result in understocked stands of reduced growth rate.

During 1948 a complete series of soil porosity tests were also run for the first time on all the 34 observation plots on the grazed watershed. The effect of the cattle trampling has been to alter the forest floor in terms of compaction and drying out of the surface soil layers for areas that have been heavily grazed. Large pore spaces in the first two inches of soil have been reduced 44 percent by volume. The soil layer 2 to 4 inches below the surface shows still greater compaction than does the surface two inches. Here the total amount of large pore spaces in the soil has been reduced 60 percent. When the soil is at field capacity, the top four inches of trampled soil will now store about 0.5 inch of water as compared with 1.2 inches before grazing. Permeability of the soil to water has been reduced ten times or more. Preliminary observations show that there has been a very marked change in the number of insects and other fauna in the soil. Although no specific measurements are available as yet, it is conceivable that all these changes are accompanied by deterioration in site due to reduced aeration and less biological activity in the soil.

SWITCH CANE RANGES HIGHLY PRODUCTIVE[5/]

The fact that beef cattle production can be highly profitable on the best switch cane ranges of the Coastal Plain has already been reported. Only

---

5/ Forest grazing studies are in cooperation with State agencies (North Carolina and Georgia), the Bureau of Animal Industry, and the Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA.

mineral supplements are needed to maintain breeding cows in a thrifty condition from May through January and to produce calves weighing 300 to 400 lbs. at weaning time in November. During 1947, additional studies were summarized showing that on vigorous switch cane ranges the grazing season can be extended from January through April by feeding protein concentrates, and that this wintering on the range is far more economical than wintering in the feed lot

Highly productive switch cane range in Washington County, N. C. On a sustained-yield basis this range will support a cow and calf on 2.8 acres from May until December. This site was formerly a hardwood forest which has been completely destroyed by repeated fires following lumbering and drainage.

Another interesting new item from the North Carolina studies is that better switch cane ranges can be used in either partially or completely finishing cattle for the market. The native range, by supplying the roughage in the fattening ration, provides the equivalent of 10 lbs. of hay per steer daily, or about 1,500 lbs. during the finishing period.

MODERATE GRAZING PAYS

Recent work on the switch cane ranges has also produced preliminary figures on range carrying capacities. About three acres of the best switch cane range are needed per cow and calf over a seven-month season under continuous moderate grazing. This type of grazing gave approximately 90 percent of the gains obtained under heavy grazing, without appreciable deterioration in the switch cane stands.

The evidence indicates that a moderate rate of stocking which results in 60 to 70 percent utilization at the end of the season under continuous summer grazing, will satisfactorily maintain forage vigor and give greatest beef production over an extended period of time. Light grazing (30 percent utilization) gives slightly better calf gains but at the expense of efficient forage utilization and income per acre. Heavy grazing (90 percent utilization) gives highest returns per acre for a few years but calves gain less, cows lose considerable weight late in the season, and forage vigor and productivity decline rapidly. On the best switch cane ranges, 2.8 acres per cow and calf proved to be a moderate rate of stocking and produced about 120 pounds of beef per acre per year.

IMPROVED KNOWLEDGE OF SWITCH CANE

During 1947-1948 substantial advances were made in our knowledge of the way switch cane grows. This offers promise of increasing the efficiency of forage management studies and grazing practices. Pertinent facts are: Most foliage growth normally occurs before mid-July. Prompt regrowth follows defoliation early in the growing season (May), and complete defoliation once a year at this time does not reduce vigor appreciably. Total defoliation at the end of the active growth period (July) results in scant regrowth and a reduction in vigor and productivity. Total defoliation in the fall (September) causes the cane to break dormancy, which results in severe winter killing of the aerial stems and stimulation of new stem production the following year. Heavy defoliation during the dormant winter season is apparently not harmful. The burning of switch cane ranges reduces yields for three years.

Rhizomes and stems of switch cane serve as storage organs for large amounts of carbohydrate foods (starch and sugar) which are available to the plant for making vegetative growth. We have shown that the level of total food reserves fluctuates widely by seasons, being lowest in spring and highest in fall. It is likely that the levels of food reserves are also influenced by grazing and that they will reflect the effects of management systems at least a year before such effects can be detected by other plant responses or cattle performance. Chemists of the Bureau of Animal Industry, a cooperating agency, have tested a simplified procedure for determining total available carbohydrates and have found it useful for measuring food reserves of switch cane.

CALF CROPS ON WIREGRASS STILL LOW

Results summarized in 1948 show that starvation losses can be eliminated by feeding small amounts of high protein feed to supplement the native forage during the fall and winter. However, the higher level of supplement used, two pounds of cottonseed meal per head per day, did not appreciably increase calf production, which continues to be the major herd management problem. Calf crops have averaged around 50 percent, with weaning weights of about 275 pounds. The feasibility of improving calf production by supplementing the range in summer, as well as in fall and winter, with protein feed or improved pasture is being investigated.

WIREGRASS RANGES CAN BE IMPROVED

Preliminary tests of promising plants show that three grasses (Dallisgrass, common Bahiagrass, and carpetgrass) and three legumes (common lespedeza, Louisiana White Dutch clover, and big trefoil) are definitely useful for range improvement. The marked superiority of improved forage over native "wiregrass" species in protein and mineral content has been demonstrated by chemical analysis and by cattle preference.

Improved species can be successfully introduced merely by broadcasting the seed onto freshly burned range if competition from native grass is held

down by heavy grazing. Fertilization greatly benefits the introduced grasses, and is essential for satisfactory performance of the legumes on most piney woods soils. Fertilizing and burning both attract cattle to seeded areas and encourage the heavy grazing required in the absence of other cultural treatments.

Disking or chopping (with a brush cutter) facilitates the establishment of introduced species, and some such cultural practice is needed on brushy range. Chemical sprays are being investigated as an alternate method of killing brush in preparation for range seeding.

NAVAL STORES[6/]

Improved practices for naval stores operators are especially important not only in the interest of better forest production in general and closer integration of the production of naval stores with other forest crops, but also because of the highly competitive position of the gum naval stores industry and the need for greater efficiency if the industry is to survive in present form. Accordingly, emphasis is being placed on studies of greater efficiency and lowered operating costs. A three-point program is being followed to accomplish this objective: (1) study of new turpentine techniques aimed at efficiency of operation, (2) development of high-yielding naval stores pines which, if grown in plantations, could yield twice the present amount of gum per tree and thereby reduce unit production costs, and (3) improvement of the mechanical efficiency of turpentining equipment. The following results are currently reported:

Gum Flow Holds Up Well Under Acid Stimulation

When the use of chemicals as a gum-flow stimulant was first proposed, a very important consideration was the possible long-range effect on the trees.

6/ Mechanization and equipment project in cooperation with Engineering Experiment Station, University of Florida, Gainesville, Florida.

Only recently a five-year test has been completed of biweekly sulfuric acid treatment--the method now used most widely by the industry. Yields during the fifth year were still high when compared to those from weekly untreated deep chipping. After the five-year treatment period, all trees were chipped in the conventional manner for one season. The gum yields were comparable to yields from untreated trees receiving regular chipping for the six-year period. These essentially equivalent yields indicate the commercial feasibility of biweekly acid treatment for five years, and at least one more year of untreated chipping.

A similar long-period study with triweekly chipping and treating substantiates the results with biweekly treatment. The level of gum production is about the same the fifth as it was during the preceding years. However, total slash pine yields were 64 percent of regular weekly untreated chipping, while longleaf pine yields were 108 percent.

Gum yields of acid treated slash and longleaf pine for a five-year period

Treatment	Yield per year in barrels per crop: 1943	1944	1945	1946	1947	Relative yields for a 5-year period
	Bbls.	Bbls	Bbls.	Bbls.	Bbls	Percent
SLASH PINE						
Weekly						
½ x ½, Untr.[1/]	203	226	258	292	298	100
Biweekly						
BC x 3/4, Acid[2/]	248	228	240	221	257	93.5
½ x 3/4, Acid	220	240	281	255	287	100.5
LONGLEAF PINE						
Weekly						
½ x ½, Untr.[1/]	145	115	126	127	131	100
Biweekly						
BC x 3/4, Acid[2/]	167	132	139	131	114	106.1
½ x 3/4, Acid	135	121	139	138	135	103.7

1/ Chipped ½-inch high and ½-inch deep; no acid applied.
2/ Bark-chipped 3/4-inch high; 40 percent sulfuric acid applied on slash and 60 percent on longleaf.

Use of Fifty Percent Acid Seems Feasible

Recommendations for use of acid in commercial practice have specified solutions at two concentrations: 40 percent for slash and 60 for longleaf. A single concentration would be decidedly advantageous, and tests with 50-percent acid have been under way for two years. In slash pine the use of 50-percent acid on a biweekly basis with 3/4-inch-high chipping raised yields to 154 percent of the controls (regular weekly chipping). In longleaf pine with biweekly chipping the yields were 151 percent of the controls with the same chipping height.

In pilot-plant tests on three commercial operations, slash pine yields with 50-percent acid and biweekly treatment averaged 213.0 barrels of gum per crop. The yield of untreated trees averaged 182.4 barrels of gum per crop from 29 streaks. Thus the yield for 14 treated streaks was about 17 percent higher than for 29 untreated streaks.

Commercial Tests Confirm High Yields With Acid Stimulation

Each year the Experiment Station, in cooperation with the Naval Stores Conservation Program, conducts a series of pilot-plant tests of chemical stimulation of gum flow, for the purpose of obtaining information on yields and costs of new turpentining methods under commercial operating conditions. In recent tests, five producers used triweekly bark chipping with 60-percent acid treatment on longleaf pine and four used biweekly treatment with 40-percent acid on slash pine.

In the tests with longleaf pine, an average yield of 1.4 barrels per streak per thousand trees was obtained. This is nearly three times the yield (0.49 barrels) per streak obtained from weekly untreated chipping. Total yields per crop of 10,000 faces were 168 barrels from 12 treated streaks and 146.2 barrels from 30 untreated weekly streaks. The efficiency of triweekly treatments over weekly chipping is readily apparent in longleaf pine. This treatment is not recommended for slash pine.

With biweekly treatment of slash pine, yields of 1.03 barrels per streak per thousand were obtained as compared with 0.51 from weekly untreated

chipping. Total yields per crop of 10,000 faces were 175.4 barrels from 17 treated streaks, and 162.7 barrels from 32 untreated weekly streaks.

Yields from pilot-plant tests of chemical stimulation

LONGLEAF

Methods tested	Average number of streaks		Average yield of gum per face		Average yield of gum per crop		Average yield per streak per M. faces	
	Treated (Number)	Untreated (Number)	Treated (Lbs.)	Untreated (Lbs.)	Treated (Bbls.)	Untreated (Bbls.)	Treated (Bbls.)	Untreated (Bbls.)
Triweekly chipping vs. weekly untreated	12	30	7.308	6.361	168.0	146.2	1.40	.49
SLASH								
Biweekly chipping vs. weekly untreated	17	32	7.630	7.077	175.4	162.7	1.03	.51

Costs for acid and spray guns were $67 per crop per season for the triweekly method and $77 for the biweekly method.

Plastic-type Spray Gun Invented

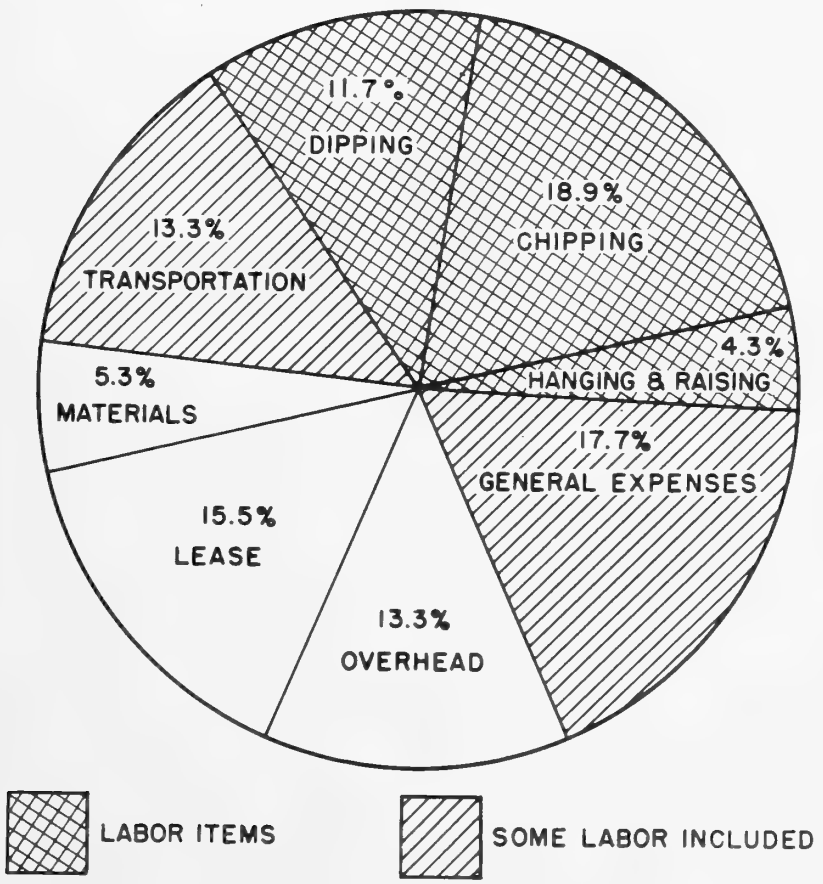
The new acid-proof, one-hand spray gun for chemical stimulation consists of a plastic nozzle and spout on a flexible plastic bottle.. The

Applying acid from a squeeze-bottle to a bark-chipped streak

spray is ejected by squeezing the bottle. This spray gun is now sold by two manufacturers. It is estimated that between 5 and 10 percent of gum-producing trees are now treated with acid. Three years ago only a small fraction of one percent was treated. The satisfactory spray gun will be an important factor in further increasing this percentage.

Chipping and Dipping Offer Best Possibility for Mechanization

A survey of the time and cost of woods operations revealed that dipping and chipping present the best possibilities for mechanization. These two jobs require walking 3,000 miles per crop per season, a distance equal to a walk across the United States. Biweekly or triweekly chipping, made possible by acid stimulation, reduces this to 1,800 or 1,425 miles, respectively. A bulletin covering this research is being published by the University of Florida.



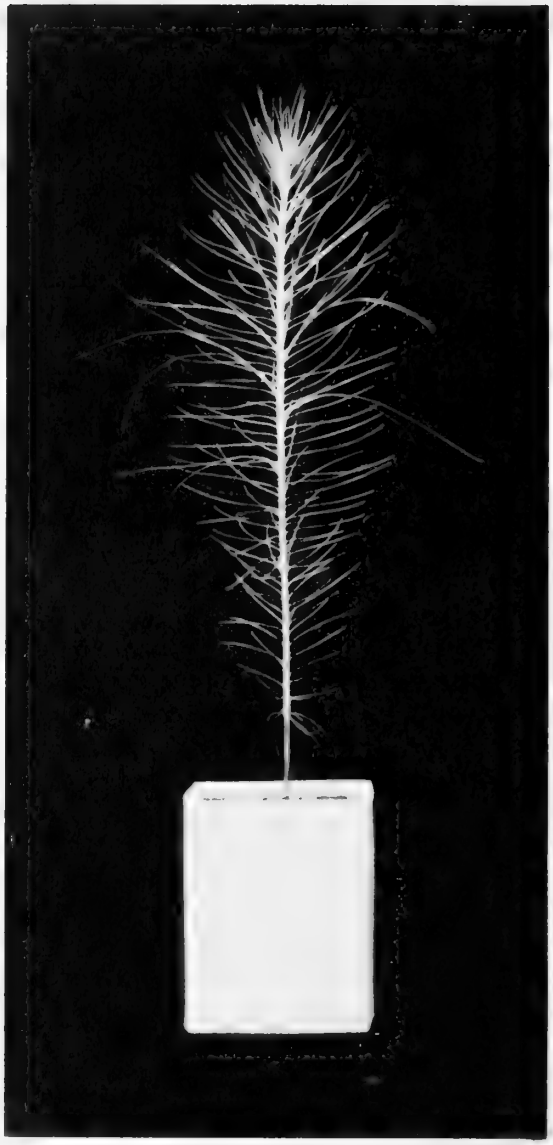
Approximate distribution of gum production costs for large operators, as of 1946.

Spiral-shaped Gutters Better With Bark Chipping

Spiral-shaped metal gutters were designed for bark chipping. These gutters fit the tree snugly. They can be used on wide faces where high gum yields are wanted for a few years; for example, on trees to be cut selectively. No gutter on the market today can be bent to the con figuration of the tree at a wide face. Preliminary results are promising; so promising that one operator wanted to try 30,000 of them.

Hybrid Progeny Now Three Years Old

Seedlings in the progeny test of crosses between slash pines of different gum-yield capacity are now three years old. The average height of seedlings is 2.5 feet, with 95.5 percent survival. In addition to this plantation, there are on hand about 1,200 seed from controlled pollinations and these will be used for additional plantings.



Slash pine seedling from a cross between superior parents. The male parent yields 100 percent and the female parent 111 percent more gum than average trees.

Tests Continue On Types and Frequencies of Chipping

Many studies with different types of chipping, face widths, frequencies of chipping and treating

are providing important gum-yield data. Information from these studies include:

1. Over a three-year period, with weekly chipping and treatment, total yields from average-size trees having two acid-treated faces were 36 percent greater than yields from trees having one acid-treated face.

2. With weekly chipping and acid treatment, increasing the face width from one-third up to three-fourths of the circumference gave 29 percent more gum in the first year. Over a three-year period the yield advantage of the wider faces was 16 percent.

3. With biweekly and triweekly schedules of acid treatment for a one-year period, doubling the normal face width gave 46 percent more gum.

4. Fertilized trees chipped and treated weekly for a three-year period have consistently yielded at least 20 percent more gum than unfertilized trees. Successively greater yields have been obtained from all trees for the past three seasons.

Noncorrosive Stimulants Tested

A noncorrosive stimulant, or one producing continuous flow over a longer period, would of course have many advantages over sulfuric acid. Preliminary tests with punch wounds and commercial-size faces show that both sulfamic acid and the morpholine salt of the weed killer 2,4-D are effective gum-flow stimulants. Gum yields were comparable to those obtained with sulfuric acid but more killing occurred in the tissue above the face. Later tests show that excessive killing above faces treated with 2,4-D is a serious disadvantage to use of this chemical.

Exploratory work shows that water may be a factor contributing to crystallization in both longleaf and slash pine gum. Freshly collected gum containing resin acid crystals, made clear by heating and then stored in stoppered vials without water, is free of crystals after 10 weeks. Other gum in stoppered vials with water added on top started to crystallize within one week after preparation. If crystallization of gum at the exposed ends of resin ducts is a cause of gum-flow stoppage, then flow might be prolonged by treatment with dehydrating agents other than sulfuric acid.

Experiments are being continued on the fungus stimulation of gum flow through inoculation with Fusarium lateritium pini. Most of this work is being carried on by the Division of Forest Pathology, BPISAE. Treating virgin streaks prolonged the period of commercially adequate gum flow (normally one week) to an average of five weeks for slash pine and three weeks for longleaf. Later rechipping and retreatment of the same faces prolonged adequate flow for an average of three weeks for slash pine and two weeks for longleaf. Although experiments have been performed at different seasons and under a variety of conditions, no reason is known to account for the difference between the prolongation induced by the initial and by later treatments.

The fungus was used in a gum-flow experiment on 80 Virginia pines at Clemson, S. C. On this species, both at Clemson and on a few trees near Asheville, N. C., gum flow following a single chipping and inoculation was season-long. The weekly yield from Virginia pine is only about one-fifth to one-fourth that of a normal slash pine. The Clemson trees, occupying about one acre, yielded 110 pounds of gum in 32 weeks.

PUBLICATIONS

BY

MEMBERS OF THE STAFF, INCLUDING COOPERATORS

for the calendar years 1947 and 1948

In Print

Bulletins, Circulars, and Miscellaneous Publications

BISWELL, H. H., and FOSTER, J. E. Is rotational grazing on native range practical? North Carolina Agr. Expt. Sta. Bul. No. 360. 17 p. May 1947.

BYRAM, G. M., and JEMISON, G. M. Some principles of visibility and their application to forest fire protection. U. S. Dept. Agr. Tech. Bul. No. 954. 61 p. March 1948.

CASSADY, JOHN T., and SHEPHERD, W. O. Grazing on forested lands. U. S. Dept. Agr. 1948 Yearbook of Agriculture: 468-472.

EVERARD, W. P., and LAKE CITY BRANCH, Southeastern Forest Experiment Station. Modern turpentining practices. U. S. Dept. Agr. Farmers' Bul. 1984. 12 p. February 1947.

HERTZLER, R. A., TODD, A. S., JR., and SMITH, WALTON R. Opportunities in rural industries - wood. North Carolina Dept. Conservation and Development Resource-Industries Series No. 4. 47 p. 1947.

HURSH, C. R. Local climate in the copper basin of Tennessee as modified by the removal of vegetation. U. S. Dept. Agr. Cir. No. 774. 38 p. January 1948.

KORSTIAN, C. F., and JAMES, L. M. Forestry in the South. Institute for Research in Social Science, University of North Carolina, for the Southern Association of Science and Industry. 57 p. 1948.

MINCKLER, L. S. Tree planting in the Central, Piedmont, and Southern Appalachian regions. U. S. Dept. Agr. Farmers' Bul. 1994. 39 p. February 1948.

SCHOPMEYER, C. S., and HELMERS, A. E. Seeding as a means of reforestation in the northern Rocky Mountain region. U. S. Dept. Agr. Cir. No. 772. 31 p. December 1947.

Technical Journals

BICKFORD, C. A., and NEWCOMB, L. S. Prescribed burning in the Florida flatwoods. Fire Control Notes 8(1): 17-23. January 1947.

BYRAM, G. M. Terrestrial radiation and its importance in some forestry problems. Jour. Forestry 46(9): 653-658. September 1948.

_____ Vegetation temperature and fire damage in the Southern pines. Fire Control Notes 9(4): 34-36. October 1948.

CAMPBELL, W. A. Phytophthora cinnamomi associated with the roots of littleleaf-diseased shortleaf pine. Plant Dis. Rptr. 32: 472. November 15, 1948.

CRUIKSHANK, J. W. Southern forests as a source of pulpwood. TAPPI Monograph Series--No. 4: 52-62. 1947.

_____ The Forest Survey tests the helicopter. Jour. Forestry 45(12): 878-883. December 1947.

DOOLITTLE, W. T. White pine blight in relation to site and thinning. Jour. Forestry 46(12): 928-929. December 1948.

DORMAN, KEITH W. Longleaf pine cuttings rooted in greenhouse. Jour. Forestry 45(8): 594. August 1947.

DOWNS, ALBERT A. Choosing pine seed trees. Jour. Forestry 45(8): 593-594. August 1947.

_____ Losses from high stumps in sprout oak stands. Jour. Forestry 45(12): 903-904. December 1947.

DUNFORD, E. G., and FLETCHER, P. W. Effects of removal of stream-bank vegetation upon water yield. Trans. Amer. Geophys. Union 28(1): 105-110. 1947.

ELLIOTT, F. A., and POMEROY, K. B. Artificial regeneration of loblolly pine on a prescribed burn. Jour. Forestry 46(4): 296-298. 1948.

GRUSCHOW, G. F. A test of methods of planting eastern redcedar in the Virginia Piedmont. Jour. Forestry 46(11): 842-843. November 1948.

HAYES, G. LLOYD Forest fires and sea breezes. Fire Control Notes 8(2 and 3): 30-33. April and July 1947.

HEPTING, GEORGE H. Stimulation of oleoresin flow in pines by a fungus. Science 105(2721): 209. February 21, 1947.

HEPTING, GEORGE H. We present Carl Hartley. Jour. Forestry 45(8): 595-596. August 1947.

_____ Littleleaf disease of pine as a problem in soils and physiology. (Abs.) Assoc. South. Agr. Workers Proc. 45: 40-41. 1948.

_____ and TOOLE, E. R. Wilt epidemiology and resistance in the mimosa tree. (Abs.) Phytopath. 38(1): 13. January 1948.

HOFFMAN, C. H., HEPTING, G. H., and ROTH, E. R. A twig droop of white pine caused by Pineus. Jour. Econ. Ent. 40: 229-231. 1947.

JEMISON, GEORGE M., and SCHUMACHER, F. X. Epicormic branching in old-growth Appalachian hardwoods. Jour. Forestry 46(4): 252-255. April 1948.

LIEBERMAN, J. A. Water resource and watershed management research in the Southeast. Amer. Water Works Assoc. Jour. 39(5): 443-454. May 1947.

_____ and FLETCHER, P. W. Further studies of the balanced water cycle on experimental watersheds. Trans. Amer. Geophy. Union 28(3): 421-424. June 1947.

_____ and HOOVER, M. D. The effect of uncontrolled logging on stream turbidity. Water & Sewage Works 95(7): 255-258. July 1948.

LINDENMUTH, A. W., JR., and BYRAM, G. M. Headfires are cooler near the ground than backfires. Fire Control Notes 9(4): 8-9. October 1948.

_____ and KEETCH, J. J. Fuel moisture sticks are accurate. Fire Control Notes 9(4): 18-21. October 1948.

MATHEWS, Andrew C. The scarification of various legume seeds with a disc scarifier. Amer. Soc. Agron. Jour. 39(4): 343-354. April 1947.

_____ Observations on methods of increasing the germination of Panicum anceps Michx. and Paspalum notatum Flugge. Amer. Soc. Agron. Jour. 39(5): 439-442. May 1947.

McCLAY, T. A. Profits from chestnut oak tanbark. Jour. Forestry 46(4): 298-299. April 1948.

POMEROY, K. B. Observations on four prescribed fires in the Coastal Plain of Virginia and North Carolina. Fire Control Notes 9(2 and 3): 13-17. April and July 1948.

ROTH, E. R. Healing and defects following oak pruning. Jour. Forestry 46(7): 500-504. July 1948.

_____ TOOLE, E. RICHARD, and HEPTING, GEORGE H. Nutritional aspects of the littleleaf disease of pine. Jour. Forestry 46(8): 578-587. August 1948.

SCHOPMEYER, C. S. Effect of 2,4-D on yields of oleoresin from slash and longleaf pines. Scientific Monthly 67(6): 440-443. December 1948.

TOOLE, E. RICHARD Distribution of mimosa wilt in 1947. Plant Dis. Rptr. 32(2): 67. February 15, 1948.

_____ SNYDER, W. C., and HEPTING, G. H. A new Fusarium wilt of sumac. (Abs.) Phytopath. 38(7): 572. July 1948.

TRUE, R. P., and SMUCKER, M. M. Symptoms induced at standardized wounds by fungi isolated from dry turpentine faces. (Abs.) Phytopath. 37: 437. June 1947.

_____ and SNOW, ALBERT G., JR. Effect of inoculation with a Fusarium on gum flow from naval stores pines. (Abs.) Phytopath. 38(7): 572-573. July 1948.

WAHLENBERG, W. G. Effect of forest shade and openings on loblolly pine seedlings. Jour. Forestry 46(11): 832-834. November 1948.

YOST, HENRY E., and HEPTING, G. H. The development of white pine blister rust in an unprotected area in North Carolina. Plant Dis. Rptr. 31: 26. 1947.

Trade and Popular Journals

BENNETT, JACKSON and FLETCHER, PETER W. Loblollies and the land. Soil Conservation XIII(5): 115. December 1947.

BISWELL, H. H., MATHEWS, A. C., BURTON, G. W., and HODGSON, H. J. Better forage is goal Tifton men work for. South. Livestock: 6, 24. March 1947.

BRENDER, ERNST V Pulpwood from tops. The Unit, News Letter No. 22 of the Southern Pulpwood Conservation Association: 10-11. October 1947. South. Lumberman 175(2201): 238-240. December 15, 1947. Pulp & Paper Mag. of Canada 49: 112. January 1948.

CAMPBELL, ROBERT A Farm woodland earnings. Forest Farmer 6(9): 4. June 1947. Also published as "Earnings from your farm woodland." Farmers Federation News 27(12): 17. August 1947.

CAMPBELL, ROBERT A. Twenty years' growth, yellow-poplar. Forest Farmer 7(5): 22. February 1948.

_____ Estimating your logging and milling costs. South. Lumberman 176(2209): 50, 52, 54, 56. April 15, 1948.

CAMPBELL, W. A. Littleleaf a problem of forest farming. Forest Farmer 6(7): 6, 8. April 1947.

_____ Littleleaf--a baffling disease of shortleaf pine. Georgia Forestry 1(11): 2-3. November 1948.

_____ Search for a root killer as the cause of littleleaf disease of pine. Forest Farmer 8(3): 4. December 1948.

CLEMENTS, RALPH W. Biweekly acid tests highly successful: 254 barrels from 17 streaks. AT-FA Jour. 9(5): 16-17. February 1947. Naval Stores Rev. 56(47): 11, 19. February 22, 1947.

_____ Costs of biweekly acid treatment from 1946 pilot-plant tests. AT-FA Jour. 9(9): 11-12. June 1947. Naval Stores Rev. 57(5): 3. May 3, 1947.

_____ Biweekly acid treatment offers larger profits. AT-FA Jour. 10(4): 11, 15. January 1948. Also published as "Biweekly chipping, acid treatment cut production costs." Naval Stores Rev. 57(43): 11, 24, 26-28. January 24, 1948.

_____ Results of 1947 pilot-plant tests of chemical stimulation. Naval Stores Rev. 58(31): 15-16. October 30, 1948. Also published in modified version as "Station announces results of 1947 acid pilot-plant tests." AT-FA Jour. 10(12): 8, 9, 16. September 1948.

CRAIG, R. B. The forest situation in Virginia. (Series of 5 articles).
Virginia Forests 2(2): 6-7, 9, 14. March-April 1947.
Virginia Forests 2(3): 8-9, 18. May-June 1947.
Virginia Forests 2(4): 8-9, 18. July-August 1947.
Virginia Forests 2(6): 6-7, 14, 16. November-December 1947.
Virginia Forests 3(1): 8-9, 13, 16. January-February 1948.

_____ Private ownership of large properties in South Carolina, 1946. Southern Pulp & Paper Manufacturer 10(10A): 46, 48. October 31, 1947.

_____ and CRUIKSHANK, J. W. Trends in timber supply of the Carolinas. The Paper Industry and Paper World 29(1): 65-68. April 1947.

CRUIKSHANK, J. W. The Forest Survey tests the helicopter. Pulp & Paper Mag. of Canada 49(1): 106, 108, 110, 112. January 1948. Also published as "Forest surveys with a helicopter." Timber of Canada 8(12): 34-35, 60, 62. August 1948.

CRUIKSHANK, J. W. Pulpwood production and the timber supply. South. Lumberman 177(2217): 39, 40. August 15, 1948.

DORMAN, KEITH W. Better pines for turpentine. Amer. Forests 53(11): 498-500 November 1947.

_____ Breeding better southern pines for the future South. Lumberman 175(2201): 147-150. December 15, 1947.

_____ Pedigreed pines for Dixie s future forests. Forest Farmer 6(8): 7. May 1947.

_____ Progress in breeding better turpentine pines. AT-FA Jour. 9(12): 10, 15. September 1947.

_____ Rooted pine cuttings make rapid growth. AT-FA Jour. 9(11): 8. August 1947.

_____ Hardwoods in the naval stores region. Naval Stores Rev. 58(26): 11-13, 25-28. September 25, 1948.

_____ and CLEMENTS, RALPH W. Results of commercial scale chemical stimulation tests. Parts II and III. Naval Stores Rev. 56(40): 7-8. January 4, 1947. Part II. Naval Stores Rev. 56 (41): 7-8. January 11, 1947. Part III.

DOWNS, ALBERT A. How pine cuttings are rooted. Forest Farmer 7(5): 26. 1948.

DUNFORD, E. G. Research in the Central Piedmont. Forest Farmer 6(12): 4, 8. September 1947.

GRUSCHOW, G. F. The Lee Experimental Forest. Virginia Forests 3(3): 6-7, 11. May-June 1948.

_____ First cutting cycle completed on the Olustee Experimental Forest. South. Lumberman 177(2225): 139-140. December 15, 1948.

HAIG, I. T. Putting research to work. Amer. Forests 54(12): 536-538, 566. December 1948.

HAWLEY, NORMAN R. Research in the longleaf-slash pine belt. Forest Farmer 6(11): 4-5. August 1947.

HEPTING, GEORGE H. Stimulation of gum flow by a fungus. Forest Farmer 6(6): 2. March 1947.

HURSH, C. R Water resource management. North Carolina Engineer 3(2): 9-12, 40. 1947.

_____ Watershed experiments conducted in giant outdoor laboratory. Timber Topics 10(4): 2-4, 9. July-August 1947. (Courtesy of American Forests).

JEMISON, G. M., and MERRICK, ELLIOTT. Improving the farm woods. Farmers Federation News 28(11): 6, 9. July 1948.

LIEBERMAN, J. A., and HOOVER, M. D. Protecting quality of stream flow by better logging. South. Lumberman 177(2225): 236-240. December 15, 1948.

LOTTI, THOMAS Forest research in the South Carolina Coastal Plain. Forest Farmer 6(4): 6, 8. January 1947.

_____ Profits from 20 years' growth. Forest Farmer 6(12): 1. September 1947.

_____ Tree grades for loblolly and shortleaf pine. Forest Farmer 8(1): 7. October 1948.

_____ and CHAIKEN, L. E. Tree grades for loblolly and shortleaf pine. South. Lumberman 177(2225): 107-109. December 15, 1948.

LUFBURROW, B. B. Olustee woodlot gives good annual income. Naval Stores Rev. 58(3): 26-28. April 17, 1948. Also published as "Farm woodlot provides good annual income." AT-FA Jour. 10(9): 8, 13. June 1948. Also in Florida Trees & Trails 3(7): 3. July 1948.

MANN, JAMES M. Prescribed burn versus wildfire. Forest Farmer 7(2): 4. November 1947.

MATHEWS, A. C., HODGSON, H. J., and BISWELL, H. H. New seeds for old piney woods ranges. South. Seedsman 10(1): 13, 57. January 1947.

McCLAY, T. A. Skidding pulpwood by use of jeep. Farmers Federation News 28(10): 3, 7. June 1948. Forest Farmer 7(10): 6. July 1948.

OSTROM, CARL E. Naval stores research at the Lake City Branch of the Southeastern Forest Experiment Station. Naval Stores Rev. International Yearbook 1948: 103-105. 1948.

_____ and TRUE, R. P. Effects of chemical stimulation on the health and vigor of treated pines. Part III. Reserve food content. AT-FA Jour. 9(4): 8-9. January 1947. Also published as "Chemical stimulation: its effect on health and vigor of treated pines. Part III. Reserve of food content." Naval Stores Rev. 56(43): 11, 14, 16. January 25, 1947.

POMEROY, K. B., and TROUSDELL, K. B. The importance of seedbed preparation in loblolly pine management. South. Lumberman 177(2225): 143-144. December 15, 1948.

ROWLAND, C. A., JR. Bud-pruning for better logs. South. Lumberman 177 (2225): 142-143. December 15, 1948.

SCHOPMEYER, C. S. A new sprayer to simplify acid treatment of turpentine faces. AT-FA Jour. 10(1): 8. October 1947. Also published as "New sprayer simplifies acid treatment of turpentine faces." Forest Farmer 7(1): 2. October 1947. Also published as "New acid sprayer." Naval Stores Rev. 57(29): 14, 28. October 25, 1947.

_____. Fall vs. spring clean-up streak for acid-treated turpentine faces. AT-FA Jour. 10(3): 6, 17. December 1947. Also published as "Clean-up streak: fall or spring?" Naval Stores Rev. 57(39): 12, 27. December 27, 1947.

_____. Forest Service advises against acid treatment while trees are still dormant. Naval Stores Rev. 57(49): 3. March 6, 1948. Also published as "Producers are advised to delay acid treatment until regular chipping season." AT-FA Jour. 10(6): 12. March 1948.

_____. Too much acid reduces gum yields. Naval Stores Rev. 58(13): 11-12. June 26, 1948.

SHEPHERD, W. O., BISWELL, H. H., and KAUFMAN, C. M. Forest grazing in North Carolina. South. Planter 108(3): 50, 51. March 1947.

SIMS, IVAN H. Research in the northern coastal plains. Forest Farmer 6(6): 6, 8. March 1947.

_____. Forest research in Virginia's Coastal Plain. Virginia Forests 3(2): 8-9, 13, 16. March-April 1948.

SMITH, WALTON R. Air seasoning and kiln drying. Part I. Wood Working Digest 49(10): 73-74, 76-78. October 1947. Part II. Wood Working Digest 49(11): 151-156. November 1947. Also published as "Air-seasoning and kiln-drying." Wood Worker: 62-63. July 1947. Also published as "Air seasoning and kiln drying." South. Lumberman 176(2203): 45-52. January 15, 1948.

_____. How do we dry lumber? South. Lumberman 175(2199): 47-52. November 15, 1947.

SOUTHEASTERN FOREST EXPERIMENT STATION, Lake City Branch Staff. Survey shows over half the cost of producing barrel of dip goes to labor. AT-FA Jour. 10(4): 6. January 1948.

_____. Distribution of costs in production of gum. Forest Farmer 7(4): 5. January 1948.

SNOW, ALBERT G., JR. How much gum can a gum tree give? Forest Farmer 6(5): 14. February 1947.

_____. Gum yields good during five years of biweekly acid treatment. Naval Stores Rev. 58(22): 11. August 28, 1948. AT-FA Jour. 10(11): 4. August 1948.

SNOW, ALBERT G., JR. Turpentining and poles. South. Lumberman 177(2225): 276, 278-279. December 15, 1948.

TODD, ARTHUR S., JR. Forest survey: how accurate are the findings? South. Lumber Jour. 52(2): 20, 96. February 10, 1948.

TOOLE, E. RICHARD Rootability of cuttings. Amer. Nurseryman 88: 72. July 15, 1948.

_____ Mimosa wilt. Forest Farmer 8(1): 9. October 1948.

TROUSDELL, KENNETH B. Some effects of a piecework system on felling and bucking costs in eastern North Carolina. South. Lumberman 175(2201): 190-192. December 15, 1947.

TRUE, R. P. Pitch canker fungus prolongs gum flow. Naval Stores Rev. 56(52): 26. March 29, 1947. AT-FA Jour. 9(7): 17. April 1947.

WENGER, KARL F. Avoid thinning understocked stands. Forest Farmer 7(6): 10-11. March 1948.

Processed

CLARK, C. K., and OSBORNE, J. G. The properties of longleaf pine oleoresin as affected by tree characteristics and management practices. Southeastern Forest Experiment Station Technical Note No. 70. AIC-191. December 1948.

CRAIG, R. B., MARBURG, T. F., and HAYES, G. L. Fire losses and justifiable protection costs in the Coastal Plain region of South Carolina. March 1947.

_____ and FRANK, B. Fire losses and justifiable protection costs in the southwestern coal section of Virginia. March 1947.

CRUIKSHANK, J. W. Southern forests as a source of pulpwood. Southeastern Forest Experiment Station Survey Release No. 22. September 1, 1947.

_____ The work of the forest survey in the Southeast. Southeastern Forest Experiment Station. November 1, 1947.

_____ 1946 pulpwood production by county in the Southeast. Southeastern Forest Experiment Station Forest Survey Release No. 23. November 15, 1947.

_____ Southern pulpwood production and the timber supply. Southeastern Forest Experiment Station Forest Survey Release No. 24. February 15, 1948.

HERTZLER, R A. Forest Products Laboratory's kiln-drying course. Transactions of Wood Seasoning Conference: 65-66. October 2-3, 1947. Asheville, N C

LINDENMUTH, ANSON W., JR. Forest fires and fire danger in New Hampshire (for year 1945). Southeastern Forest Experiment Station. March 26, 1947.

_____ 1946 fire danger--Region 7 national forests. Southeastern Forest Experiment Station. September 8, 1947.

_____ 1946 forest fires and fire danger in Connecticut, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, Pennsylvania, Rhode Island, Vermont, and Virginia. 1947. 1946 forest fires and fire danger in New York, West Virginia. 1948. (13 separate reports, by individual states). Southeastern Forest Experiment Station.

_____ 1947 forest fires and fire danger in Connecticut, New York, Rhode Island, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, Pennsylvania, Vermont, Virginia, West Virginia. (13 separate reports, by states). Southeastern Forest Experiment Station. 1948.

_____ 1947 fire danger--Region 7 national forests. Southeastern Forest Experiment Station. August 18, 1948.

LOTTI, THOMAS A guide to the Santee Experimental Forest. Southeastern Forest Experiment Station. March 1948.

McCLAY, T A Farm woodland management at the Bent Creek Experimental Forest; report for the years 1946 and 1947. Southeastern Forest Experiment Station. 1948.

McCORMACK, J. F. 1946 commodity drain by county from South Carolina forests. Southeastern Forest Experiment Station Forest Survey Release No. 26. March 15, 1948.

_____ 1947 pulpwood production by county in the Southeast. Southeastern Forest Experiment Station Forest Survey Release No. 27. August 10, 1948.

RENSHAW, J. F A guide to the Bent Creek Experimental Forest. Southeastern Forest Experiment Station. November 1948.

ROTH, ELMER R , BUCHANAN, THOMAS S., and HEPTING, GEORGE H. A five-year record of littleleaf on thirty-one plots. U. S. Dept. Agr., Bureau of Plant Industry, Soils, and Agr. Engr., Division of Forest Pathology, Forest Pathology Special Release No. 32. April 1948.

SMITH, WALTON R. How do we dry lumber? Transactions of Wood Seasoning Conference, Asheville, N. C. October 2-3, 1947.

SNOW, ALBERT G , JR. Effect of sulphuric acid on gum yields from slash and longleaf pines. Southeastern Forest Experiment Station Technical Note No. 68. June 30, 1948.

SOUTHEASTERN FOREST EXPERIMENT STATION, Division of Forest Influences Staff. Water resource management in the Southeastern states: discussion outline; water requirements; water quality; water units and measurements; field observations. (Series of discussions for Know-Your-Watersheds Training Program) 1947.

_____ Watershed management research - Coweeta Experimental Forest. March 1948.

_____ Lake City Branch Staff. Annotated bibliography of naval stores practices and the management of naval stores timber for the year 1947. 1948.

_____ Central Coastal Plain Branch Staff. Tree grades for loblolly and shortleaf pine. Southeastern Forest Experiment Station Technical Note No. 69. August 30, 1948.

_____ Bibliography of the Southeastern Forest Experiment Station from July 1, 1946 to December 31, 1947. 1948.

TODD, ARTHUR S., JR., and CRAIG, R. B. Forest resources of the lower Coastal Plain of South Carolina. Southeastern Forest Experiment Station Forest Survey Release No. 25, March 1, 1948.

MANUSCRIPTS SUBMITTED
BY
MEMBERS OF THE STAFF, INCLUDING COOPERATORS
for the calendar years 1947 and 1948

Publication pending, as of December 31, 1948

CAMPBELL, W. A. A method of isolating Phytophthora cinnamomi from soil. Plant Dis. Rptr.

CRADDOCK, GEORGE W., and HURSH, CHARLES R. Watersheds and how to care for them. U. S. Dept. Agr. 1949 Yearbook of Agriculture

CRAIG, RONALD B. Virginia forest resources and industries. U. S. Dept. Agr. Misc. Pub.

COPELAND, OTIS L., JR. Some relations between soils and the littleleaf disease of pine. Jour. Forestry Notes.

_____ Relationship of soils to littleleaf disease of pine. Forest Farmer.

DOWNS, ALBERT A. Trees and food from acorns. U. S. Dept. Agr. 1949 Yearbook of Agriculture.

DORMAN, KEITH W. Slash pine from British Honduras outgrows the American kind. Forest Farmer.

HAWLEY, NORMAN R. Old rice plantations in and around the Santee Experimental Forest. Agricultural History.

HAYES, G. LLOYD. Forest fire danger measurement as an aid in fire control. U. S. Dept. of Agr. 1949 Yearbook of Agriculture.

HEPTING, GEORGE H. Managing pine in littleleaf areas. Forest Farmer.

_____ Littleleaf as a problem in soils and physiology. Abs. Assoc. South. Agr. Workers Proc.

_____ and KIMMEY, J. W. Heart rot--a multimillion dollar loss largely preventable. U. S. Dept. Agr. 1949 Yearbook of Agriculture.

_____ ROTH, ELMER R., and SLEETH, BAILEY. Discolorations and decay from increment borings. Jour. Forestry.

HERTZLER, R. A., and SMITH, WALTON R. The preservative treatment of Virginia's fence posts. Virginia State Dept. of Planning and Economic Development.

JEMISON, GEORGE M., and HEPTING, GEORGE H. Timber stand improvement in the Southern Appalachian region. U. S. Dept. Agr. Tech. Bul.

LARSON, ROBERT W. Saw-timber supply decreasing in South Carolina. South. Lumberman.

LEMON, PAUL C. Successional responses of piney woods forage plants after fire. Ecology.

LIEBERMAN, J. A., and HOOVER, M. D. Streamflow frequency changes on Coweeta Experimental Watersheds. Amer. Geophysical Union.

LINDAHL, IVAN, DAVIS, R. E., and SHEPHERD, W. O. The application of the total available carbohydrate method to the study of carbohydrate reserves of switch cane (Arundinaria tecta). Plant Physiology.

LINDENMUTH, A. W., JR. Trends in fire danger measurement research in the South. The Annual Ring, publication of Louisiana State University, School of Forestry.

LINDGREN, RALPH M., TRUE, RODNEY P., and TOOLE, E. Richard. Trees for use around the home in the South. U. S. Dept. Agr. 1949 Yearbook of Agriculture.

OSTROM, CARL E , and SQUIRES, JOHN W. Wood, gum, and grass. U. S. Dept. Agr. 1949 Yearbook of Agriculture.

POMEROY, KENNETH B. Can hardwoods be controlled? Virginia Forests.

SMITH, WALTON R. Furniture and forestry. Virginia Forests.

_____ Wood-sugar molasses may reduce wood waste problem in the South. Carolina Lumber & Building Supply Assoc.

SNYDER, W. C., TOOLE, E. R., and HEPTING, G. H. Fusaria associated with mimosa wilt, sumac wilt, and pine pitch canker. Jour. Agr. Res.

TOOLE, E. R. White pine blight in the Southeast. Jour. Forestry.

_____ and HEPTING, G. H. Selection and propagation of Albizzia for resistance to Fusarium wilt. Phytopathology.

TRUE, R P. Dry face of turpentined pines. Forest Farmer.

_____ and SNOW, ALBERT G., JR Gum yields from fungus-treated faces. Naval Stores Rev. and AT-FA Jour.

ZAK, BRATISLAV. The search for a virus as the cause of littleleaf. Forest Farmer.